FORM PTO-1390 (REV 10-2000) U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER	
43048/240338	
U S APPLICATION NO (If known, see 37 C F R 1 5)	
10/019908	

INTERNATIONAL APPLICATION NO	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/EP00/04043	May 6, 2000	May 10, 1999

TITLE OF INVENTION

SUPPLY METER AND METHOD FOR READING A FIXED SUPPLY METER

APPLICANT(S) FOR DO/EO/US

Michael Schröter

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.

2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.

3. ☒ This is an express request to promptly begin national examination procedures (35 U.S.C. 371(f))

4. ☐ The US has been elected by the expiration of 19 months from the priority date (PCT Article 31).

5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   - a. ☒ is attached hereto (required only if not communicated by the International Bureau).
   - b. ☐ has been communicated by the International Bureau.
   - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).

6. ☒ A English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).

7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   - b. ☐ have been communicated by the International Bureau.
   - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   - d. ☐ have not been made and will not be made.

8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).

9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).

10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. To 16. Below concern other document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 C.F.R. 1.97 and 1.98.

12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.

13. ☒ A FIRST preliminary amendment.
    ☐ A SECOND or SUBSEQUENT preliminary amendment

14. ☐ A substitute specification.

15. ☐ A change of power of attorney and/or address letter.

16. ☒ Other items or information: 10 pages of drawings

U.S. APPLICATION NO. (If known, see 37 CFR 1.5) 10/019908	INTERNATIONAL APPLICATION NO PCT/EP00/04043	ATTORNEY'S DOCKET NUMBER 43048/240338

17. ☒ The following fees are submitted:		CALCULATIONS	PTO USE ONLY
Basic National Fee (37 CFR 1.492(a)(1)-(5)): Neither international preliminary examination fee (37 CFR 1.482) nor International search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO	**$1,040.00**		
International preliminary examination fee (37 CRF 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO	**$ 890.00**		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search (37CFR 1.445(a)(2)) paid to USPTO	**$ 740.00**		
International preliminary examination fee (37 CFR 1.482) paid to USPTO But all claims did not satisfy provisions of PCT Article 33(1)-(4)	**$ 710.00**		
International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4)	**$ 100.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT	=	**$ 890.00**	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).		**$**	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total Claims	24 -20 =	4	X $18.00	$ 72.00	
Independent Claims	2 - 3 =	0	X $84.00	$ 0.00	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ $280.00	$	
		TOTAL OF ABOVE CALCULATIONS =		$ 962.00	
☒ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by one-half.				$ 481.00	
		SUBTOTAL =		$ 481.00	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				$	
		TOTAL NATIONAL FEE =		$ 481.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$	
		TOTAL FEES ENCLOSED =		$ 481.00	
				Amount to be Refunded	$
				Charged	$

a. ☒ A check in the amount of $ 481.00 to cover the above fees is enclosed.
b. ☐ Please charge my Deposit Account No. 16-0605 in the amount of $ to cover the above fees. A duplicate copy of this sheet is enclosed.
c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 16-0605.

Note: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:
James A. Witherspoon
SIGNATURE
REGISTRATION NUMBER 36,723
ALSTON & BIRD LLP
Bank of America Plaza
101 South Tryon Street, Suite 4000
Charlotte, NC 28280-4000
Tel Charlotte Office (704) 444-1000
Fax Charlotte Office (704) 444-1111
Customer Number 00826

"Express Mail" Mailing Label Number EL 913134748 US
Date of Deposit. November 9, 2001

I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to BOX PCT, Attn: DO/US (PTO) Commissioner for Patents, Washington, DC 20231.

Joyce D. Smith

05963v1

IN THE UNITED STATES DESIGNATED OFFICE (DO/US)

In re:	Schroter	Attn: DO/US
International Appl. No.:	PCT/EP00/04043	
International Filing Date:	May 6, 2000	
For:	SUPPLY METER AND METHOD FOR READING A FIXED SUPPLY METER	

March 12, 2002

Box PCT
Commissioner for Patents
Washington, DC 20231

PRELIMINARY AMENDMENT

Sir:

Please amend the above-identified application as follows:

In the Specification:

Please replace the originally filed Specification, inclusive of the Abstract, with the Substitute Specification, which includes an Abstract, filed herewith.

In The Claims:

Please cancel Claims 1-24.

Please add the following new Claims 25-67.

25. (New) A supply meter system, comprising:

a supply meter for measuring a consumption value and including a viewing field for alphanumerically displaying the measured value in an optically readable form, with the viewing field having an optical configuration and an optical situation;

a frame that is in the form of hollow shell having opposite first and second ends, with the first end adapted to a surface of the supply meter and placed thereon so that the shell extends around the viewing field;

an image reader for obtaining an image of the viewing field, wherein the image reader includes a camera mounted to the second end of the shell, with the camera having an optical system that is adapted to the optical configuration and the optical situation of the viewing field, wherein the shell produces a predetermined spacing between the camera and said surface of the supply meter, the shell establishes an orientation of the optical system of the camera toward the viewing field, and the shell extends around the optical system;

a light source for illuminating the viewing field, wherein the light source is positioned above the viewing field by the shell and the shell extends around the light source; and

a display connected to the camera for displaying the image of the viewing field.

26. (New) A supply meter system according to claim 25, wherein the shell is cylindrical.

27. (New) A supply meter system according to claim 25, wherein the viewing field is positioned behind an inspection window of the supply meter, the inspection window includes a lens, and optical properties of the lens and geometric relations between the lens and the viewing field define the optical configuration and the optical situation of the viewing field.

28. (New) A supply meter system according to claim 25, wherein the viewing field is positioned behind an inspection window of the supply meter, and the supply meter, the image reader, and the shell form a hermetically sealed, watertight, and dust-proof unit that is positioned above the inspection window.

29. (New) A supply meter system according to claim 25, wherein the light source includes at least one light emitter and at least a portion of the shell that is in the form of a hollow light ring of a transparent or translucent material which surrounds the optical system of the camera in a substantially concentric relationship, with the light ring including an end face, which faces the camera, and an exit surface, which faces the viewing field of the supply meter, and the light emitter is on top of the end face for radiating light beams into the light ring, with the exit

surface of the light ring sloping toward the viewing field of the supply meter in such a manner that light beams exit from said exit surface and strike the viewing field.

30. (New) A supply meter system according to claim 29, wherein the light ring is cylindrical.

31. (New) A supply meter system according to claim 29, wherein the end face of the light ring is annular, and a plurality of light emitters are circumferentially distributed over the end face of the light ring in such a manner that adjusting illumination of the viewing field according to needs by corresponding arrangements of the light emitters on the end face of the light ring is possible.

32. (New) A supply meter system according to claim 29, wherein a plurality of light emitters are evenly circumferentially distributed over the end face of the light ring.

33. (New) A supply meter system according to claim 29, wherein the supply meter includes a glass cover and the viewing field is positioned behind the glass cover.

34. (New) A supply meter system according to claim 33, wherein the exit surface slopes toward the glass cover in such a manner that the light beams exiting from said exit surface hit the glass cover at a predetermined angle of incidence that takes into account the refraction on the glass cover so that the light penetrates the glass cover substantially free of reflections.

35. (New) A supply meter system according to claim 33, wherein a reflection surface is on an end of the light ring that faces the glass cover, the reflection surface reflects the light beams, and the reflection surface slopes toward the glass cover such that the light beams in the light ring are projected on the exit surface of the light ring at a substantially acute angle.

36. (New) A supply meter system according to claim 33, wherein the exit surface of

the light ring includes annular grooves with a prismatic axial section for refracting the emerging light beams in the direction of the glass cover of the supply meter.

37. (New) A supply meter system according to claim 33, wherein between the light ring and the viewing field of the supply meter, a reflector ring with a conical reflector surface facing the viewing field is arranged in concentric relationship with the light ring, and inclined in such a manner that the light beams emerging from the exit surface and striking the reflector surface are reflected toward the glass cover.

38. (New) A supply meter system according to claim 33, wherein a reflector ring is between the light ring and the viewing field, the reflector ring includes a conical reflector surface that is facing the viewing field and arranged in concentric relationship with the light ring, and inclined in such a manner that any light beams that are reflected from the glass cover are reflected by the reflector surface toward the glass cover.

39. (New) A supply meter system according to claim 29, wherein a reflector ring is between the light ring and the viewing field, the reflector ring includes a conical reflector surface that is facing the viewing field and arranged in concentric relationship with the light ring, and the reflector ring serves as at least a part of the frame.

40. (New) A supply meter system according to claim 29, wherein the light source includes a plurality of light emitters that provide light of a limited wave range such that the light is substantially monochromatic and includes green or yellow light.

41. (New) A supply meter system according to claim 25, further comprising a second camera mounted to a support so that the second camera is in a predetermined position above the display for recording data shown on the display.

42. (New) A supply meter system according to claim 41, wherein the support

connects to a protective cylinder, the protective cylinder surrounds the second camera in its predetermined position and the display, and the protective cylinder shields the second camera and the display from extraneous light.

43. (New) A supply meter system according to claim 25, wherein the camera is a digital camera that is operative for recording and storing the image of the viewing field of the supply meter.

44. (New) A supply meter system according to claim 43, wherein the optical system of the digital camera includes a lens, and the supply meter system further includes a shutter that is positioned between the lens and the viewing field of the supply meter, and the shutter is for limiting detail of the image that is recorded and stored by the digital camera.

45. (New) A supply meter system according to claim 25, wherein the image reader is connected to a computer.

46. (New) A supply meter system according to claim 45, wherein the image reader is connected to the computer via a wireless communication system selected from the group consisting of: a radio communication system, an ultrasound communication system, and an infrared communication system.

47. (New) A supply meter system according to claim 45, wherein the computer is a central computer that is positioned remotely from the supply meter, and the central computer is capable of being contemporaneously connected a plurality of image readers.

48. (New) A supply meter system according to claim 45, wherein the computer is equipped with a program for an alphanumerical evaluation of images of alphanumerical characters obtained by the image reader.

49. (New) A supply meter system according to claim 48, including:

a memory for storing the images of alphanumerical characters in the form of digital signals;

means for comparing the digital signals of an image for correspondence with stored signals of all alphanumerical characters; and

means for outputting an alphanumerical character as a consumption value of a reading location in the form of the electronic signal train of that alphanumerical character whose stored image corresponds with the read image.

50. (New) A supply meter system according to claim 45, wherein the image reader is connected to a data storage for storing alphanumerical data contained in the image of the viewing field.

51. (New) A supply meter system according to claim 50, including:

means for storing a first and a second reading time;

means for transferring and reading into the computer a sequence of signals, which represent information selected from a group consisting of a consumption value and identification data of a reading location at the first and the second reading time;

a program for an alphanumerical evaluation of read customer data of the first and the second reading time with a storage for storing the alphanumerically evaluated customer data of the first and the second reading time;

a second reading of information selected from a group consisting of a consumption value and identification data of the reading location on the supply meter after expiration of a reading time interval; and

means for comparing the alphanumerically evaluated customer data of the first and the second reading time and for computing a consumption between the first and the second reading time of the former and the current consumption value.

52. (New) A supply meter system according to claim 51, including means for

outputting a written consumption voucher in the amount of the consumption.

53. (New) A supply meter system according to claim 45, wherein the computer comprises a program and an outputting device for carrying out a money transfer by remote debiting.

54. (New) A supply meter system according to claim 52, wherein the storage of the data occurs in the computer, which is associated in spatially close relationship with the image reader, and which includes connection elements for connecting to a communication network.

55. (New) A supply meter system according to claim 45, wherein the image reader is provided with a time-dependent switch, which is used to activate the image reader and the illumination of the viewing field of the supply meter for reading current data of the supply meter.

56. (New) A supply meter system according to claim 51, including time measuring means for determining the first and the second reading time.

57. (New) A supply meter system according to claim 25, wherein the supply meter is a water meter that includes a glass cover through which the consumption value is seen as a line of numerals on the viewing field, which is immersed in water.

58. (New) A supply meter system according to claim 57, wherein the image reader further includes a light-sensitive photodetector, which is directed toward a movable surface with markings located behind the glass cover, and a microprocessor connected to the photodetector and including a comparator, wherein the photodetector and microprocessor are operative for detecting at predetermined time intervals a change in position of the movable surface, wherein a moving speed of the movable surface is a function of the amount of consumption determined by the supply meter, and a frequency of light pulses generated by the markings is a function of the amount of consumption determined by the supply meter.

59. (New) A supply meter system according to claim 58, wherein the light source is a first light source, and the movable surface is illuminated by a second light source.

60. (New) A supply meter system according to claim 45, wherein the supply meter includes an inscription for identifying the location of the supply meter, and the image reader is provided with means for recording, transferring and reading into the computer signals representing the inscription which identifies the location of the supply meter.

61. (New) A supply meter system, comprising:

a supply meter for measuring a consumption value and including a viewing field for alphanumerically displaying the measured value in an optically readable form, with the viewing field having an optical configuration and an optical situation;

a frame that is in the form of a hollow shell having opposite first and second ends, with the first end adapted to a surface of the supply meter and placed thereon so that the shell extends around the viewing field;

a scanner mounted to the second end of the shell for obtaining an image of the viewing field by way of a point-by-point recording and storage of the image, with the scanner having an optical system that is adapted to the optical configuration and the optical situation of the viewing field, wherein the shell produces a predetermined spacing between the scanner and said surface of the supply meter, the shell establishes an orientation of the optical system of the scanner toward the viewing field, and the shell extends around the optical system;

a light source for illuminating the viewing field, wherein the light source is positioned above the viewing field by the shell and the shell extends around the light source; and

a display connected to the scanner for displaying the image of the viewing field.

62. (New) A supply meter system, comprising:

a supply meter for measuring a consumption value and including a viewing field for alphanumerically displaying the measured value in an optically readable form, with the viewing

field having an optical configuration and an optical situation;

a guide system on the supply meter;

an electronic image reader positioned above the viewing field by the guide system for obtaining an image of the viewing field, with the image reader having an optical system that is adapted to the optical configuration and the optical situation of the viewing field;

a display connected to the image reader for displaying the image of the viewing field; and

a light source for illuminating the viewing field, with the light source including at least one light emitter and a hollow light ring of a transparent or translucent material which surrounds the optical system of the image reader in a substantially concentric relationship,

wherein the light ring includes an end face, which faces the image reader, and an exit surface, which faces the viewing field of the supply meter, and the light emitter is positioned on the end face for radiating light beams into the light ring, with the exit surface of the light ring sloping toward the viewing field of the supply meter in such a manner that light beams exit from said exit surface and strike the viewing field.

63. (New) A supply meter system according to claim 62, wherein the light ring is cylindrical.

64. (New) A supply meter system according to claim 62, wherein the guide system includes the light ring.

65. (New) A supply meter system, comprising:

a supply meter for measuring a consumption value, and including a viewing field for alphanumerically displaying the measured value in an optically readable form, with the viewing field having an optical configuration and an optical situation;

a guide system on the supply meter;

a light source positioned above the viewing field by the guide system for illuminating the viewing field;

an electronic image reader positioned above the viewing field by the guide system for

obtaining an image of the viewing field, with the image reader having an optical system that is adapted to the optical configuration and the optical situation of the viewing field;

a display connected to the image reader and operative for displaying the image of the viewing field; and

a camera mounted to a support so that the camera is in a predetermined position above the display for recording data shown on the display.

66. (New) A supply meter system, comprising:

a supply meter for measuring a consumption value and including a viewing field for alphanumerically displaying the measured value in an optically readable form, with the viewing field having an optical configuration and an optical situation;

a guide system on the supply meter;

a light source positioned above the viewing field by the guide system for illuminating the viewing field;

a digital camera positioned above the viewing field by the guide system for obtaining an image of the viewing field, with the camera having an optical system that is adapted to the optical configuration and to the optical situation of the viewing field, and the optical system includes a lens;

a display connected to the image reader and operative for displaying the image of the viewing field; and

a shutter positioned between the lens of the digital camera and the viewing field of the supply meter for limiting detail of the image of the viewing field.

67. (New) A supply meter system, comprising:

a supply meter for measuring a consumption value and including a viewing field for alphanumerically displaying the measured value in an optically readable form, with the viewing field having an optical configuration and an optical situation;

a guide system on the supply meter;

an electronic image reader positioned above the viewing field by the guide system for

obtaining an image of the viewing field, with the image reader having an optical system that is adapted to the optical configuration and the optical situation of the viewing field;

a light source positioned above the viewing field by the guide system for illuminating the viewing field;

a display connected to the image reader and operative for displaying the image of the viewing field;

means for storing a first and a second reading time;

means for transferring and reading into the computer a sequence of signals, which represent information selected from a group consisting of a consumption value and identification data of a reading location at the first and the second reading time;

a program for an alphanumerical evaluation of read customer data of the first and the second reading time with a storage for storing the alphanumerically evaluated customer data of the first and the second reading time;

a second reading of information selected from a group consisting of a consumption value and identification data of the reading location after expiration of a reading time interval; and

means for comparing the alphanumerically evaluated customer data of the first and the second reading time and for computing a consumption between the first and the second reading time of the former and the current consumption value.

REMARKS

This Amendment is being filed to place the present application in condition for examination under U.S. practice. Please enter this Amendment before substantively examining this application.

Respectfully submitted,

James A. Witherspoon
Registration No. 36,723

ALSTON & BIRD LLP
Bank of America Plaza
101 South Tryon Street, Suite 4000
Charlotte, NC 28280-4000
Tel Charlotte Office (704) 444-1000
Fax Charlotte Office (704) 444-1111
Customer No. 00826
#4524155v1

CERTIFICATE OF EXPRESS MAILING

"Express Mail" mailing label number EL 910299133 US
Date of Deposit March 12, 2002

I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to Box PCT, Commissioner For Patents, Washington, DC 20231.

Joyce D. Smith

Attorney's Docket No. 43048/240338 Rec'd PCT/PTO 12 MAR 2001

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re: Schroter
International Appl. No.: PCT/EP00/04043
International Filing Date: May 6, 2000
For: SUPPLY METER AND METHOD FOR READING A FIXED SUPPLY METER

Commissioner for Patents
Washington, DC 20231

STATEMENT UNDER 37 C.F.R. §1.125(b)
REGARDING SUBSTITUTE SPECIFICATION

I hereby state that the Substitute Specification filed concurrently herewith is in compliance with 37 C.F.R. §125. The Substitute Specification incorporates the originally filed specification and drawings, and contains no new matter. In accordance with 37 C.F.R. §1.125(b)(2), a marked-up version of the Substitute Specification showing all of the changes (including the matter being added to and the matter being deleted from) is also enclosed.

Respectfully submitted,

James A. Witherspoon
Registration No. 36,723

CUSTOMER NO. 00826
ALSTON & BIRD LLP
Bank of America Plaza
101 South Tryon Street, Suite 4000
Charlotte, NC 28280-4000
Tel Charlotte Office (704) 444-1000
Fax Charlotte Office (704) 444-1111
#4524187v1

CERTIFICATE OF EXPRESS MAILING

"Express Mail" mailing label number EL 910299133 US
Date of Deposit March 12, 2002

I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to Box PCT, Commissioner For Patents, Washington, DC 20231.

Joyce D. Smith

SUBSTITUTE SPECIFICATION

SUPPLY METER AND METHOD FOR READING A FIXED SUPPLY METER

BACKGROUND OF THE INVENTION

The present invention relates to supply meters and methods of reading stationary supply meters.

Supply meters are generally known and used for measuring, for example, the consumption of water. To determine the consumption, supply meters of this kind require an optical reading of numerals "by hand," and associating them to a consumer or a household. Since supply meters are rarely arranged in a place that is favorable for reading, the reading is time-consuming, at times very difficult, and even affected by unreliability.

SUMMARY OF THE INVENTION

One aspect of the present invention is the provision of an improved supply meter and method of reading the supply meter such that it is possible to determine the value of consumption in a simple, fast, reliable, and in particular independent manner from the local environmental situation of the supply meter.

In accordance with one aspect of the present invention, a supply meter, which is for measuring and displaying a measured value, includes an inspection window. An optically readable display of the measured value is provided by a counting mechanism that is behind the inspection window. The measured value is alphanumerically shown on the display. Further in accordance with this aspect, an electronic image reader is associated to the supply meter. The image reader is positioned above the inspection window by way of a guide system. The image reader includes an optical system that

is adapted to the optical configuration of the inspection window and to the optical situation, in particular the geometric position of the display behind the inspection window.

The foregoing aspect has the advantage that it permits a cost-favorable determination of the value of consumption. Likewise, without further activity by a person, it is possible to obtain, with the use of data technology, the determined consumption values by an electronic computer, as well as to determine the consumption and to prepare the bill for the consumption automatically. The present invention provides suitable mechanical and optical adaptation that make it possible to use commercially available image readers for determining the consumption, thereby eliminating human sources of error.

A person may guide such image readers by hand. In this case, the reading head of these image readers has essentially the size of a hand (see, VDI Nachrichten, No. 12, March 26, 1999).

The intended guide system of the image reader permits arranging the image reader, in particular a digital camera, above the display window of the supply meter such that it is possible to recognize fully and read simultaneously all numerals of the consumption rate or other characters and marks being read from the display window, such as in particular an identification number, which is assigned to each consumer or household.

The guide system that is provided to this end may be, for example, a template placed on the image reader, in which the image reader is arranged or laterally movable, depending on the size of the detection range of the image reader. The template is adapted to the supply meter such that it can be placed on the supply meter only

in very specific positions, and that, as a result, the image reader is arranged above the inspection window of the supply meter only in a very specific direction, or that it can be guided over the inspection window of the image reader.

Thus, the invention proceeds from the recognition that a reliable reading and errorless recognition of the numerals and characters appearing in the inspection window of the supply meter will be ensured with the use of a digital image reader only when the image reader is adapted in an optimal manner, by means of an adapted guide system in a defined position with an always identical display field, to the sizes, colors, and contrasts, and other visual conditions, as well as to light conditions.

In accordance with one aspect of the present invention, the guide system is arranged on the image reader and includes an adapter, which permits the guide system to be placed on the supply meter for positioning the camera. As a result, even in the case of conventional supply meters, it is possible to produce the combination of supply meter, guide system, and image reader in a manner that provides for the reading operation of the present invention. In this connection, the guide system may be mounted to the image reader. It is not necessary that a guide system be rigidly arranged on each supply meter.

For example, the guide system may be guide rails, which are arranged above the inspection window of the supply meter. In this instance, the reading head of the image reader is designed and constructed such that it is guided in or on the guide rails in a certain direction and position.

In accordance with one aspect of the present invention, the guide system is a frame with one end adapted to the meter in the region of the viewing area and placed thereon. The other end of the frame mounts or is adapted to receive the image reader. In accordance with this aspect, the image reader is a camera. The frame produces a predetermined spacing between the camera and the viewing area of the supply meter, as well as an alignment of the optical system of the camera with the viewing field. This aspect has the advantage that the reading operation becomes largely independent of human influence and corresponding sources of human error. The viewing field is recorded as a whole in a single exposure step. The association of the read value of consumption to a certain household occurs in that besides the consumption value, all other data which are needed for determining the consumption of a certain household or consumer are recorded via optical systems and, if need be, with the use of data systems, and that they are electronically stored. This also includes identification marks, which are arranged on the meter in a tamperproof manner.

The optical systems of such image readers may very made highly photosensitive, so that it is possible to read at least the consumption values or identification marks in existing daylight or artificial light. In accordance with one aspect of the present invention, the image reader connects to a light source for illuminating the display of a consumption value and/or an identification mark. The light source is preferably mounted to the camera or to the guide system. Therefore, the reading reliability and reading accuracy are independent of environmental conditions and in particular of light conditions.

In accordance with one aspect of the present invention, the light source consists of a hollow-cylindrical light ring of a transparent or translucent material, which surrounds the optical system of the camera in a substantially concentric relationship. The light source also includes one or more light emitters that are arranged on the front side of the light ring facing the camera, for radiating into the light ring. The light ring preferably serves as at least a part of the guide system. This aspect permits a very uniform illumination, thereby ensuring readability and recognizability of the characters being read from the inspection window. Corresponding arrangements of the light emitters on the annular end face of the light ring make it possible to adjust the illumination of the viewing area according to requirements.

It is of special importance that the light beams be directed toward the supply meter in such a manner that the light beams are not reflected on the inspection window. This is accomplished by a predetermined configuration of the light ring. Additionally, a reflector can be positioned so that any light beams that are reflected by the inspection window do not return to the image reader in a manner such that they are wrongly interpreted by the image reader.

In accordance with one aspect of the present invention, is its possible to omit a special guide system. In accordance with this aspect, preferably the light ring and/or the reflector ring function as a guide system or at least as a part thereof.

For the recognizability of the numerals and other characters being read, it will be of special advantage when the image reader and light emitter or light sources are adapted to one another in a manner that allows for

the utilization of a substantially monochromatic light or light of a limited wave range, in particular in the green or yellow range. In this instance, one may select wave lengths of the light which are especially low in reflection.

In accordance with one aspect, the present invention is used with water meters, which is particularly advantageous since water meters are often arranged in very unfavorable locations.

In comparison with supply meters of other media, a water meter has the unique characteristic that the counting mechanism and numerical scale are immersed in water. While this requires a special adaptation of the optical system, it also has the advantage that the counting mechanism is not susceptible to contamination. This also applies to the identification mark, when the identification mark is under the inspection window. In this instance, the inspection window may be constructed as a lens, primarily a weak lens, for purposes of improving the recognizability of numerals and other characters.

As aforesaid, the invention has the advantage that it also permits, via data systems, a further processing of the recorded consumption values or identification marks, since the image reader in its current marketable design records the determined numerals not only as an image, but also in digitized form. For the correct recognition and display of these images, and for the conversion of these images into alphanumerical characters, special marks may be used in the lines in which the values being read are located. For converting the images into alphanumerical characters, an OCR (optical character recognition) software is used.

The image reader, which is used within the scope of the present invention, is preferably a digital camera. It may also be a laser scanner, which scans the viewing area line by line in a predetermined and controlled sequence, with the light value of the recorded image points being stored in a reproducible manner.

The currently marketed image readers make it possible to show the read data on a display, so that, in accordance with one aspect of the present invention, the operator is able to enter the recorded data by hand into a written document.

One may avoid optical errors, inaccuracies, or ambiguities of the image provided by the image reader, such as by producing a clear black and white image of the viewing area when the image reader is connected to a computer, which clearly allocates each image point of the viewing area to a binary signal (black or white). Such a display has a definition[,] which is not realizable with merely optical means.

The use of a digital camera also has the advantage that when reading a display, the recording element of the camera shows the correct position. As a result of connecting the image reader to a computer, it is [however] also possible to rotate the viewing area automatically during the reading, so as to enable a reading "by hand" and/or a comparison of the recorded characters with characters that are predetermined and stored in the computer. Likewise, by engaging the image reader and the guide system on the supply meter, it is possible to predetermine that the image reader has the correct alignment with the viewing area.

For monitoring the operation of the supply meter over a long period of time with little energy consumption, as well as for the safety and reliability of

this monitoring, other aspects of the present invention are provided. For one of these aspects, the image reader is connected to a comparison device as well as to a computer and software, which permit detecting at predetermined time intervals the change of the image points of at least a partial area of the inspection window, in which a control wheel with markings or another moved surface with markings is arranged. For another of these aspects, the image reader includes a photosensitive photodetector, which is directed toward a control wheel with markings located in the inspection window, or another movable surface with markings, and a microprocessor connected thereto, which determines the frequency of the light pulses generated by the markings. For both of these aspects, the moving speed of the control wheel or other surface depends on the function of the supply meter and preferably on the amount of consumption. According to these aspects, this monitoring system is designed such that is does not adversely affect the reading of the consumption.

If an operator continues to read the supply meters, the reading will be simplified by the invention, and be made more reliable. However, it is also possible to include operations in the reading step that have previously had to occur subsequently by evaluating the read values. That is, in accordance with another aspect of the present invention, data systems are provided for the processing of the recorded consumption values and identification marks up to and including an automatic writing of bills.

In many cases, supply meters are arranged in inaccessible locations, for example, in chemical plants or manholes. In these cases, the reading of the consumption values is not only difficult, but also

associated with hazards. A stationary installation of the image reader and the guide system on the supply meter, and the connection of the image reader to an associated computer, permit eliminating this problem.

With its different developments, the invention also enables a variable realization of the reading method. In this connection, different steps of automation are possible. One option is a continuous automation, including the evaluation of the consumption values and, if need be, preparation of bills.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following, the invention is described with reference to embodiments shown in the drawings, in which:

Figure 1 is a view of a water meter;

Figure 2 is a partially sectioned view of a water meter with a sectional view of an image reader;

Figure 3 is a partially sectioned view of a water meter with a sectional view of a camera;

Figure 4 is a view of a water meter of Figure 3;

Figure 5 is a cross sectional view of a supply meter with remote data transmission;

Figure 6 is a cross sectional view of the optical system, the light ring, and the supply meter of an embodiment (partial);

Figure 7 is a sectional view of an image reader, guide system, and consumption body with an additional light source, and a supply meter with a control wheel;

Figures 8, 8a-b show the reading of consumption values, which originate in a manhole; and

Figures 9A-9D are detailed views of light rings.

DETAILED DESCRIPTION OF THE INVENTION

The devices illustrated in Figures 1-9 are largely identical. In the following description, parts of identical function are provided with the same numerals. The following description applies to all Figures and embodiments, unless express reference is made to the differences.

A water meter **1** comprises a housing **4**, which is upwardly closed, toward the viewing side, by an inspection window **3**, and sealed by an annular seal or gasket **5**. The housing **4** is flooded in water. The housing **4** accommodates a counting mechanism **2**. This counting mechanism connects to measuring wheels (not shown) of the water meter. The inspection window is in the form of an optical lens, and designed and constructed such that it makes readily visible, in particular visible by enlargement, the number (count, consumption value) shown on the display (counting mechanism), and that it compensates for optical distortions, which arise due to the fact that the counting mechanism is immersed in water. Furthermore, the water meter **1** comprises an identification mark **12** shown by the number 4711. This identification mark is assigned to the water meter and its location, for example, a certain water consuming point. The identification mark (meter number) is used to be able to allocate the consumption value of a certain consuming point, which is read on the counting mechanism (display **2**), to a certain consuming point, and, last but not least, to write a bill to a certain person.

The identification mark **12** is arranged on an identification sign, which cannot be removed, altered, or damaged from the outside. In the illustrated embodiment, the identification sign is likewise arranged in the water-flooded housing such that the identification mark

12 appears parallel to and in the vicinity of the consumption value shown on the counting mechanism, and that it can be simultaneously read with same.

The following applies to the embodiment of Figures 1 and 2:

Above the inspection window, the edge of the housing mounts guide rails **6.1, 6.2, 6.3**. Each pair of guide rails **6.1** and **6.2** is associated to the consumption value shown on the counting mechanism, and a further pair of guide rails **6.2** and **6.3** is associated to the identification mark **12**. The guide rails **6.1-6.3** are made as V-shaped or T-shaped sections. Above the base of these sections, an image reader **9** may be guided. To this end, cross members adjacent to the guide rails **6.1** and **6.2** and **6.2** and **6.3**, respectively, are arranged in such a spaced relationship that the image reader can be successively guided over the consumption value and over the identification mark, and in so doing record respectively the consumption value and the identification mark.

The necessary accuracy of the guidance depends on the one hand on the geometrical design of the head of image reader **9**, and on the other hand on the aperture angle of the optical system. In the embodiment, the optical system of the image reader is shown only schematically and symbolically by a lens **7** and a photosensitive receiver **8**. Such image readers are presently commercially available, and will therefore not be described in further detail.

In the embodiment of Figures 3-4, the recording of the consumption value and identification mark occur by an image reader **9**, which is realized as a camera. This camera **9** is able to record with a single adjustment the entire viewing field of the water meter **1**. By means of a

guide system **6**, the camera is aligned with the viewing field, i.e. both display **2** and identification mark **12**. The guide system **6** is a shell of a cylinder or frustum. The lower end face thereof is adapted to the outer contours of the water meter **1**, and placed on the water meter. The upper end face is adapted to the contours of the camera or attachment for lens **7**, and comprises in addition an aperture for two light sources **15** and the preceding focusing lenses. The guide system **6** may be an independent structural element, which is placed on the water meter, when needed, and which subsequently receives the camera. In this instance, it is possible to ensure the correct position, in particular the rotated position, by cooperating marks, notches, optical markings, or the like provided on the guide body on the one hand, and on the housing of the water meter or the camera on the other hand.

The guide system **6** may also be made integral with the water meter. In this instance, marks will be needed only on the pairing of the camera and guide body **6**. On the other hand, the guide body **6** may also be made integral with the camera or lens attachment. In this instance, marks are provided only on the pairing of the cylinder body and supply meter.

The following applies to all embodiments:

The optical system of the image reader **9** is adapted to the optical system of inspection window **3**; the spacing between the reading head with lens **7** on the one hand, and the inspection window **3** on the other hand; as well as the spacing between inspection window **3** and counting mechanism **2**, in such a manner that it is possible to identify in a reliable manner, even under unfavorable conditions, the respective consumption value by means of the receiver and the electronic devices not shown in

further detail. This means that the optical system of the image reader, the optical system of the inspection window, and the thereby visible counting mechanism, as well as the arrangement of guide rails **6.1-6.3** or guide body **6** must be adapted to one another.

A starting mark **13**, in the present embodiment in the form of the letter A, is permanently arranged before the consumption value, which appears on the counting mechanism. The image reader is programmed in such a manner that the read consumption value is always read and displayed from the starting mark **13**, irrespective of the direction, in which the image reader is moved along rails **6.1** and **6.2**.

In the same way, the identification mark **12** is provided with a starting mark, in the present embodiment in the form of the letter combination NR. Likewise, this starting mark serves the purpose of putting by a corresponding programming, the image reader in a position to display the identification mark always in the correct direction. By a corresponding programming of the image reader, it is further recognized with reference to starting marks **13** and **14**, which of them is the identification mark, and which is the consumption value. Thus, it does not matter whether or not the operator guides the image reader in a certain sequence, namely first over the consumption value, and then over the identification mark.

Furthermore, the type of counter can be made readable for the image reader by a marking, in the present embodiment: Qnx.

In the illustrated embodiments, the image reader is provided with one or two light sources **15** and a corresponding source of energy (not shown). Through the lens **10** or a corresponding optical system, the light

strikes the consumption value or the identification mark such that it provides an always constant and optimally suitable illumination for the image reader.

Commercially available digital image readers and cameras now include program storages, or can be connected to program storages, which permit recognizing images, and which make the recognized images recognizable on a small display arranged on the image reader. Thus, the operator is in a position to read the read consumption value and the identification mark immediately. However, it is also possible to supply the read value, via a data line **11**, to a small carry-on computer. In this computer, it is possible to convert the consumption value and the identification mark respectively into an alphanumerical signal. The computer may also store the result of previous readings as well as the owner of the consuming point. This makes it possible to convert the read data immediately into a bill to a certain person, and to issue it by means of a suitable printer.

In the embodiment of Figures 3 and 4, it will also be possible to place the guide body **6** and the camera in a randomly rotated position on the supply meter, when the computer connected to the electronic-digital camera has a suitable software, which permits rotating the read image (namely, first the read image of the consumption value and then the read image of the identification mark, if need be) to such an extent that the computer is able to identify the read-in image as a sequence of alphanumerical characters. As in the case of standard character programs, this rotation may be performed by hand. However, a corresponding programming makes it also possible to perform the rotation automatically, until the correct position is reached. The computer or software is able to recognize by a corresponding marking (for

example, starting mark "A"), whether or not the correct position is reached. However, programming may also be such that the rotation is terminated when the computer recognizes that one of the read characters corresponds to a stored alphanumerical character. The computer is now able to convert the image of the consumption value and identification mark into the corresponding alphanumerical characters and to then evaluate the received signals.

The computer may be connected to the image reader of the first embodiment or the camera of the second embodiment by cable, cable and plug connections, or even by remote transmission, by radio, infrared, and the like.

The embodiment of Figures 3-4 makes it also possible to interconnect the camera, guide body **6**, and supply meter **1** permanently. This will be especially suitable when the supply meter is located in manholes or other hard-to-access locations. In this instance, one may provide a remote control for actuating the camera and the light source. The remote control can be a cable or wireless, in particular via radio, ultrasound, or infrared. The output signals of the camera may then be supplied via a cable, or wireless, to the computer, which is located preferably always outside of the hard-to-access location.

The embodiment of Figure 5 shows that the supply meter of this invention can also very advantageously be used in hard-to-access locations. Shown is a water meter **1**, which measures the flow through a line **17**. The line **17** is laid in an underground tunnel **16**. The tunnel is accessible through a manhole **18**, which may also measure several meters deep. In the manhole, the water meter can be accessed. As is known, the access to such manholes is hazardous, since gases may accumulate in such tunnels and manholes, which lead to suffocation of the maintenance

personnel. Consequently, the reading of water meters in such locations always requires two persons.

In the illustrated embodiment, the water meter is permanently equipped with an image reader **9**, with a guide system **6** being interposed. The image reader includes a battery **21** as an energy storage. This battery is used to supply a radio set **19** and a remote releasing device **24**. Both are permanently connected to the image reader. The contact from the operator to the image reader is made, for example, via a portable radio set **20**, which is connected to a computer **22**. The computer **22** is operated via a keyboard. In this manner, it is possible to input, for example, a code number for the water meter or the image reader, and to thus establish the connection to the image reader. The remote releasing device is to be actuated by radio contact, and in this way the consumption value is read by the image reader and transmitted to the computer.

The image reader of Figure 6 permits illuminating the viewing field under the inspection window **3** of a water meter very uniformly and adapted to the conditions. In this embodiment, the guide system **6** is formed by a hollow-cylindrical holder **31**. A plurality of light emitters **27** are distributed over the inner circumference of the holder. Below the emitters is a hollow-cylindrical light ring **26**, and therebelow a reflection ring **30**. Preferably, the light ring is a transparent, at least translucent, hollow-cylindrical body of glass, Plexiglas, or the like. On the upper end face the light emitters **27** are arranged in a certain distribution. This distribution permits defining the illumination of the viewing field. The light beams penetrate the light ring **26** in the axial direction, and exit from an opposite end face **29**. In the region of this end face **29**, the light

ring is shaped such that its surface faces the viewing field, and forms an annular surface in the shape of a conical shell. In the holder **31**, below end face **29**, a reflection ring **30** is arranged, without impeding the light incidence from end face **29** onto the viewing field. The reflection ring **30** possesses an inner circumferential surface, which forms likewise an annular surface in the shape of a conical shell in facing relationship with the viewing field of the supply meter. However, this annular surface has a different angle of inclination. The light exiting from the end face (exit surface) **29** of the light ring with a certain inclination toward the viewing area has the advantage that the light beams strike the viewing area substantially not perpendicularly. This prevents not only a shadow formation, but also the reflection of the light in the direction of the light ring.

Figures 9a-d are detail views of a plurality of configurations of light rings.

In the embodiment of Figure 9a, the exit surface **29** faces the inspection window such that the light beams do not reflect from this surface, but exit and, in so doing, refract, so that they strike the inspection window.

The same applies to the embodiments of Figures 9b-d. However, each embodiment of Figures 9B-9D includes a reflection surface on the light ring, upon which the light beams impinge, and from which they are projected back into the light ring, so that they impinge upon the exit surface at a favorable angle. This angle is selected by the different relative positions of the reflection surface to the exit surface, which is exemplary in the figures, so that the light beams emerge from the exit surface completely though, but with a refraction directed toward the inspection window. In Figure 9d, the exit surface is additionally provided with

prismatic, annular grooves, which permit further influencing of the refraction and deflection of the light beams. As regards the configuration of Figures 9c-d, it is further noteworthy that the exit surface is the lower part of the circular-cylindrical inner shell of the annular ring, which is made possible by a skillful arrangement of the reflection surface.

The inclination of the annular reflection surface of reflection ring **30** is selected such that the light beams, which emanate from the end face **29** of the light ring, and which are reflected on inspection window **3**, are again reflected on the reflection surface of reflection ring **30** to the inspection window, and then contribute to the illumination of the viewing field due to the changed angle of incidence. Figure 6 shows on the left a light beam which leaves end face **29**, and is reflected by reflection on the inspection window or viewing field of the supply meter directly to the optical system **7** of the image reader. On the right side, a light beam is shown which emanates from end face **29**, and is first reflected on inspection window **3** to the annular reflection surface of the reflection ring. Only then is it used for illuminating the viewing field.

As is further shown in Figure 6, but generally advantageous in all embodiments, a shutter **28** precedes the optical system with lens **7** of the image reader. Other than is usual in a camera, this shutter is arranged not between the lens and the photosensitive receiver **8**, but between the lens and the object being recorded. This shutter **28** serves the purpose of eliminating rays in the edge regions of the lens, which tend to scatter in particular, and thus fail to produce clear images. Consequently, the shutter **28** is used to display the

numerals and other characters with a high definition, and to make them recognizable.

Moreover, it will also serve this purpose when light of a special color, and in particular also light of a narrow wave range, is produced (monochromatic light). To this end, the light sources on the one hand and photosensitive receivers **8** on the other hand are adapted to one another, so as to produce and receive only light of a certain wave length. Especially suited are green shades or yellow shades, in particular for water meters, since light of this wave range penetrates water especially well. Not only monochromatic light, but also polarized light have the advantage that a uniform, even refraction occurs, so that stray light is avoided with a defined adjustment of the image reader.

Yet, it cannot be avoided that the receiver registers the individual image points of the viewing field with unclear brightness values. The transitions between insignificant portions of the viewing field and the there displayed numerals and characters are flowing. With the use of a microprocessor, which forms a part of the computer or image reader, it is possible to accomplish that image points which exceed a certain brightness value (white level) are always displayed in white or in another way as bright, and that image points which exceed a certain darkness value (gray scale value) are always displayed dark, in particular in black. In this manner, it is possible to make with the use of the image reader the recorded image substantially clearer than it is in reality.

As shown in the embodiment of Figure 7, it is also possible to integrate a device which permits monitoring the proper operation of the supply meter. To this end, water meters have control wheels which are put into

motion by the water flow, and whose rotation and rotational speed indicate that the water consumption is registered. Such a control wheel (impeller wheel **33**) is shown in the viewing area of the water meter of Figure 4. In the embodiment of Figure 7, this impeller wheel **33** is scanned by the light beams of a control lamp **38**, which may be, for example, a diode, transmitter diode, or light-emitting diode. The light-emitting diode is directed toward the rotating surface of control wheel **33**. The reflected light beams of the light-emitting diode are received by a photodetector **35**. With a focusing lens **36** and an optical filter **37**, the photodetector **35** is likewise directed to the surface of control wheel **33**. Independently of the image reader, the photodetector **35** connects to a signaling device, which measures, for example, the frequency of light fluctuations. The frequency fluctuation results from the fact that the control wheel **33** has on its scanned surface markings in a certain spaced relationship. The detected frequency is a measure for the proper operation of the supply meter.

It is useful that the light beams of the light-emitting diode **36** have a different wave length than the light sources for illuminating the viewing field during the reading of the consumption values. This avoids mutual interferences. Such monitoring functions will be especially useful when the image reader is permanently installed on the supply meter. By way of a corresponding signaling, it will be possible to exchange the supply meter immediately, when a breakdown of its operation is signaled.

The device for scanning the control wheel is arranged on the previously described shutter ring, and precedes lens **7**. This arrangement in this location permits arranging the device for monitoring the control

wheel in very close relationship with the viewing field. This is advantageous, since only a small intensity of light is needed, and interferences are avoided. Interferences coming from the outside are prevented in particular in that the light ring and the cylindrical holder **31** surround the devices for scanning the control wheel.

The embodiments enable not only the reading of consumption values free of human errors, but also a simultaneous evaluation of the consumption value. In this connection, it will be especially advantageous when the camera and/or the computer also include an electronic storage, which permits permanently storing the identification mark or customer data, and intermittently the consumption value. In this connection, it should be remarked that it will also be possible to store the identification mark invariably and permanently in the camera, when same is stationarily mounted on the supply meter. In this instance, a special identification mark is not needed on the supply meter. Moreover, the storage of at least the last consumption value will make it possible to also compute the consumption value simultaneously with the next reading of the count. After the computation, the oldest meter count (consumption value) may be erased. This procedure makes it also possible to issue at the same time, when the count is read, a voucher, for example, a bill for the consumption to the customer, who is identified by the identification mark.

The invention makes it possible to show on a display the consumption values of the reading location. These values may then be taken over by the operator. Furthermore, it is possible to transfer the consumption values from the reading location to the storage of a

computer that is carried along by the operator. After reading a plurality of supply meters, the consumption values may then be transferred to a central computer, which is in charge of the computation of the consumption, as well as the payment thereof, as well as the writing of bills.

The herewith realized advantages relate in particular to operations from reading to inputting the consumption values in the central computer.

However, a substantially more extensive streamlining is accomplished in that the carry-on computer is also set up for storing preceding consumption values with the inclusion of the respective identification numbers. It will therefore be very advantageous when the computer is also equipped with an output device, in particular a printer. This will make it possible to compute, in situ, without the aid of the central computer, the consumption and the payment therefor, and to write a bill to the respective consumer. Via telephone or other telecommunication lines, it will also be possible to debit directly the bank account of the customer by way of an online accounting of the payment for the consumption.

Likewise, the embodiment of Figure 8 shows a supply meter of the present invention, which is used in a hard-to-access location. In essence, its description corresponds to that of Figure 5. Likewise in this embodiment, the water meter is permanently equipped with an image reader **9** with an interposed guide system **6**. The guide system **6** is a conical shell, which is placed with its lower end face in hermetically sealed relationship on the water meter, and which mounts the image reader in hermetically sealed relationship on its upper end face, thus forming a hermetically sealed unit, which prevents penetration of humidity and dirt.

The image reader is connected via a cable **11** to a display **39**. The display **39** is stationarily mounted in the upper region of a manhole or outside thereof. However, it may also be portable. In this instance, the cable mounts at its end an adapter, which can be coupled with the display. A structural unit **40**, in which the display is integrated, includes a battery **21** as an energy storage device. This battery is used to supply the image reader **9** and display **39**. The structural unit **40** further includes an adapter, in which a support **41** may be inserted such that it has an accurately defined position relative to the display **39**. A further camera (transmission camera) **42** may be mounted to the free end of support **41**. This camera is a normal camera, whose receiving carrier is however adapted to the light beams used by the display.

Figure 8a is an enlarged view of the structural unit and the transmission camera. The support can be pivoted by means of a hinge to its operating position or to the side. It is important that the support also includes a protective cylinder **47**, which surrounds in the operating position of the support the camera **42**, when installed, and protects it against extraneous light. The protective cylinder may also accommodate a filter **48**, which is adapted to the light emitted by display **39**. By means of this filter, it is possible to realize a binary conversion of the signals coming from the display, so that the transmission camera receives their light signals only as "existing" or "nonexistent." Both the image recording device **9** and the transmission camera **42** are always identically adjusted and focused. With that, it is possible to ensure that the recordings occur always fast and always of the same quality.

The operator can activate the energy supply and the connection to the image reader **9** on the structural unit **40** by means of a switch **46**. As a result, the read data of the water meter appear on the display **39**. The display is then photographed by the transmission camera **42**. The recorded image of the display may then be digitized and directly transmitted, for example, by a portable radio set **20** to a remote computer **22**. In the illustrated embodiment, the remote computer **22**, which is not shown, is provided with a scanner. The image produced by the camera **42** is thus read into the computer, so that the computer is able to evaluate the read data of the water meter and prepare a bill for the consumption.

The structural unit, or alternatively the image recording device, may be provided with a storage and a timing device. The timing device permits reading the water meter at predetermined times, for example, at the first of each month, and storing the read data. In this case, the stored data are shown on the display **39** by activating the structural unit, and then transferred to the transmission camera.

The display is shown in Figure 8b. The display includes not only an image component, but also, within the recording range of the transmission camera, a control display **43**, in which light signals **44** are able to display the status of the counter, and/or a sequence of numerals **45** as the code number for the water meter. Likewise, these data are photographed by the transmission camera **42** and subsequently read into the computer.

In the same way as in the embodiment of Figure 6, the present embodiment also permits illuminating the viewing field under the inspection window **3** of a water meter in a very uniform manner and adapted to the

conditions. The description of Figure 6 is herewith incorporated by reference.

ABSTRACT

An electronic image reader (9) is associated to a supply meter (1), for example a water meter, for measuring and displaying a measured value in an optically readable manner. This image reader is adapted for being positioned or guided in guide systems above an inspection window (3) of the supply meter. The image reader (9) is provided with an optical system, that includes a lens (7), which is adapted to the optical configuration of the inspection window and to the optical situation, in particular the geometric position of a display (2) behind the inspection window. The supply meter includes an identification mark (12), which is also located in the region of a guide system, namely guide rails (6.2, 6.3), and which is arranged relative to the guide system such that it can be read with the image reader without changing its optical system.

SUBSTITUTE SPECIFICATION
(MARKED-UP VERSION)

SUPPLY METER AND METHOD FOR READING A FIXED SUPPLY METER

BACKGROUND OF THE INVENTION

The present invention relates to [a] supply meters [as defined in the preamble of claim 1,] and [a] methods of reading [a] stationary supply meters [as defined in the preamble of claim 22].

Supply meters are generally known and used for measuring, for example, the consumption of water. To determine the consumption, supply meters of this kind require an optical reading of numerals "by hand," and associating them to a consumer or a household. Since supply meters are rarely arranged in a place that is favorable for reading, the reading is time-consuming, at times very difficult, and even affected by unreliability.

SUMMARY OF THE INVENTION

[It is an object] One aspect of the present invention is the provision of an improved [to improve the] supply meter and [the] method of reading the supply meter such that it is possible to determine the value of consumption in a simple, fast, reliable, and in particular independent manner from the local environmental situation of the supply meter.

[The solution results respectively from claim 1 and claim 22.]

In accordance with one aspect of the present invention, a supply meter, which is for measuring and displaying a measured value, includes an inspection window. An optically readable display of the measured value is provided by a counting mechanism that is behind

the inspection window. The measured value is alphanumerically shown on the display. Further in accordance with this aspect, an electronic image reader is associated to the supply meter. The image reader is positioned above the inspection window by way of a guide system. The image reader includes an optical system that is adapted to the optical configuration of the inspection window and to the optical situation, in particular the geometric position of the display behind the inspection window.

The foregoing aspect [solution] has the advantage that it permits a cost-favorable determination of the value of consumption. Likewise, without further activity by a person, it is possible to [further process] obtain, with the use of [the] data technology, the determined consumption values by an electronic computer, as well as to determine the consumption and to prepare the bill for the consumption automatically. The present invention provides [makes it possible to use by means of a] suitable mechanical and optical adaptation[,] that make it possible to use commercially available image readers for determining the consumption, thereby eliminating human sources of error.

A person may guide such image readers by hand. In this case, the reading head of these image readers has essentially the size of a hand (see, VDI Nachrichten, No. 12, March 26, 1999).

The intended guide system of the image reader[,] permits arranging the image reader, in particular a digital camera, above the display window of the supply meter such that it is possible to recognize fully and read simultaneously all numerals of the consumption rate or other characters and marks being read from the display

window, such as in particular an identification number, which is assigned to each consumer or household.

The guide system that is provided to this end[,] may be, for example, a template placed on the image reader, in which the image reader is arranged or laterally movable, [--] depending on the size of the detection range of the image reader. The template is adapted to the supply meter such that it can be placed on the supply meter only in very specific positions, and that, as a result, the image reader is arranged above the inspection window of the supply meter only in a very specific direction, or that it can be guided over the inspection window of the image reader.

Thus, the invention proceeds from the recognition that a reliable reading and errorless recognition of the numerals and characters appearing in the inspection window of the supply meter will be ensured with the use of a digital image reader only[,] when the image reader is adapted in an optimal manner, by means of an adapted guide system in a defined position with an always identical display field, to the sizes, colors, and contrasts, and other visual conditions, as well as to light conditions.

[The development of claim 2 accomplishes that] In accordance with one aspect of the present invention, the guide system is arranged on the image reader and includes an adapter, which permits the guide system to be placed on the supply meter for positioning the camera. As a result, even in the case of conventional supply meters, it is possible to produce the combination of supply meter, guide system, and image reader[, which is necessary] in a manner that provides for the reading operation of the present invention. In this connection, the guide system may be mounted to the image reader. It

is not necessary that a guide system be rigidly arranged on each supply meter.

For example, the guide system may be guide rails, which are arranged above the inspection window of the supply meter. In this instance, the reading head of the image reader is designed and constructed such that it is guided in or on the guide rails in a certain direction and position.

[The further development of claim 3] In accordance with one aspect of the present invention, the guide system is a frame with one end adapted to the meter in the region of the viewing area and placed thereon. The other end of the frame mounts or is adapted to receive the image reader. In accordance with this aspect, the image reader is a camera. The frame produces a predetermined spacing between the camera and the viewing area of the supply meter, as well as an alignment of the optical system of the camera with the viewing field. This aspect has the advantage that the reading operation becomes largely independent of human influence and corresponding [human] sources of human error. The viewing field is recorded as a whole in a single exposure step. The association of the read value of consumption to a certain household occurs in that besides the consumption value, all other data[,] which are needed for determining the consumption of a certain household or consumer[,] are recorded via optical systems and, if need be, with the use of data systems, and that they are electronically stored. This also includes identification marks, which are arranged on the meter in a tamperproof manner.

The optical systems of such image readers may very made highly photosensitive, so that it is possible to read at least the consumption values or identification

marks in existing daylight or artificial light. In accordance with one aspect of the present invention, the image reader connects to a light source for illuminating the display of a consumption value and/or an identification mark. The light source is preferably mounted to the camera or to the guide system. [In the advantageous development of claim 4,] Therefore, the reading reliability and reading accuracy are independent of environmental conditions and in particular of light conditions.

[The development of claim 5 distinguishes itself in that it] In accordance with one aspect of the present invention, the light source consists of a hollow-cylindrical light ring of a transparent or translucent material, which surrounds the optical system of the camera in a substantially concentric relationship. The light source also includes one or more light emitters that are arranged on the front side of the light ring facing the camera, for radiating into the light ring. The light ring preferably serves as at least a part of the guide system. This aspect permits a very uniform illumination, thereby ensuring readability and recognizability of the characters being read from the inspection window. Corresponding arrangements of the light emitters on the annular end face of the light ring make it possible to adjust the illumination of the viewing area according to requirements.

It is of special importance that the light beams be directed toward the supply meter[, which has an inspection window that covers the viewing area,] in such a manner that the light beams are not reflected on the inspection window. This is accomplished by a [corresponding] predetermined configuration of the light ring[s]. [in accordance with the development of claims

6, 7, and 8. With that, it is avoided that] Additionally, a reflector can be positioned so that any light beams that are reflected by [on] the inspection window[,] do not return to the image reader[, and] in a manner such that they are wrongly interpreted by the image reader.

[Likewise the development of claim 9 is used for avoiding reflections.

In the developments of claims 5-9,] In accordance with one aspect of the present invention, is its possible to omit a special guide system. [Instead, they propose to use] In accordance with this aspect, preferably the light ring[,] and/or the reflector ring function as a guide system or at least as a part thereof.

For the recognizability of the numerals and other characters being read, it will be of special advantage[,] when the image reader and light emitter or light sources are adapted to one another in a manner that allows for the utilization of a substantially monochromatic light or light of a limited wave range, in particular in the green or yellow range. [in accordance with claim 10.] In this instance, one may select wave lengths of the light[,] which are especially low in reflection.

In accordance with one aspect, the present invention [finds an especially advantageous] is used with water meters, which is particularly advantageous [in the development of claim 11,] since water meters are often arranged in very unfavorable locations.

In comparison with supply meters of other media, a water meter has the unique characteristic that the counting mechanism and numerical scale are immersed in water. While[,] this requires a special adaptation of the optical system, it also has the advantage that the counting mechanism is not susceptible to contamination.

This also applies to the identification mark, [even] when [same] the identification mark is under the inspection window. In this instance, the inspection window may be constructed as a lens, primarily a weak lens, for purposes of improving the recognizability of numerals and other characters.

As aforesaid, the invention has the advantage that [is] it also permits, via data systems, a further processing of the recorded consumption values or identification marks, since the image reader in its current marketable design [first] records the determined numerals not only as an image, but also in digitized form. For the correct recognition and display of these images, and for the conversion of these images into alphanumerical characters, special marks [of the lines] may be used[,] in the lines in which the values being read are located. For converting the images into alphanumerical characters, an OCR (optical character recognition) software is used.

The image reader, which is used within the scope of the present invention, is preferably a digital camera [(claim 12)]. It may also be a laser scanner, which scans the viewing area line by line in a predetermined and controlled sequence, with the light value of the recorded image points being stored in a reproducible manner [(claim 11)].

The currently marketed image readers make it possible to show the read data on a display, so that, in accordance with one aspect of the present invention, the operator is able to enter the recorded data by hand into a written document[, provided one of the developments defined in claims 1-13 has been met at least in a manner corresponding to the respective requirements].

One may avoid optical errors, inaccuracies, or ambiguities of the image [design] provided by the image reader[, and produce a] , such as by producing a clear[ly] black and white image of the viewing area[, in that] when the image reader is connected to a computer, which clearly allocates each image point of the viewing area to a binary signal (black or white). Such a display has a definition[,] which is not realizable with merely optical means.

The use of a digital camera also has the advantage that when reading a display, the recording element of the camera shows the correct position. As a result of connecting the image reader to a computer, it is [however] also possible to rotate the viewing area automatically during the reading, so as to enable a reading "by hand" and/or a comparison of the recorded characters with characters that are predetermined and stored in the computer. Likewise, by engaging the image reader and the guide system on the supply meter, it is possible to predetermine that the image reader has the correct alignment with the viewing area.

[To be able to] For monitoring the operation of the supply meter [likewise] over a long period of time with little energy consumption, as well as for the safety and reliability of this monitoring, [the developments of claim 14 or in particular claim 15 are proposed.] other aspects of the present invention are provided. For one of these aspects, the image reader is connected to a comparison device as well as to a computer and software, which permit detecting at predetermined time intervals the change of the image points of at least a partial area of the inspection window, in which a control wheel with markings or another moved surface with markings is arranged. For another of these aspects, the image reader

includes a photosensitive photodetector, which is directed toward a control wheel with markings located in the inspection window, or another movable surface with markings, and a microprocessor connected thereto, which determines the frequency of the light pulses generated by the markings. For both of these aspects, the moving speed of the control wheel or other surface depends on the function of the supply meter and preferably on the amount of consumption. According to [claim 16] these aspects, this monitoring system is designed such that is does not adversely affect the reading of the consumption.

If an operator continues to read the supply meters, the reading will be simplified by the invention, and be made more reliable. However, it is also possible to include operations in the reading step[, operations] that have [so far] previously had to occur subsequently by evaluating the read values. [The development of claim 18 enables via] That is, in accordance with another aspect of the present invention, data systems are provided for the processing of the recorded consumption values and identification marks up to and including an automatic writing of bills.

In many cases, supply meters are arranged in inaccessible locations, for example, in chemical plants or manholes. In these cases, the reading of the consumption values is not only difficult, but also [connected] associated with hazards. A stationary installation of the image reader and the guide system on the supply meter, and the connection of the image reader to an associated computer, permit eliminating this problem[, in particular in the development of claims 18, 19, 20, and 21].

With its different developments, the invention also enables a variable realization of the reading method. In

this connection, different steps of automation are possible. [However, the object is also] One option is a continuous automation, including the evaluation of the consumption values and, if need be, preparation of bills. [This object is met by the method of claim 22 with the variations of claims 23 and 24.]

BRIEF DESCRIPTION OF THE DRAWINGS

In the following, the invention is described with reference to embodiments[.

In] shown in the drawings, in which:

Figure 1 is a view of a water meter;

Figure 2 is a partially sectioned view of a water meter with a sectional view of an image reader;

Figure 3 is a partially sectioned view of a water meter with a sectional view of a camera;

Figure 4 is a view of a water meter of Figure 3;

Figure 5 is a cross sectional view of a supply meter with remote data transmission;

Figure 6 is a cross sectional view of the optical system, the light ring, and the supply meter of an embodiment (partial);

Figure 7 is a sectional view of an image reader, guide system, and consumption body with an additional light source, and a supply meter with a control wheel;

Figures 8, 8a-b show the reading of consumption values, which [result] originate in a manhole; and

Figures 9A-9D [9 is a] are detailed views of [the image readers of Figures 6 and 8] light rings.

DETAILED DESCRIPTION OF THE INVENTION

The devices illustrated in Figures 1-9 are largely identical. In the following description, parts of identical function are provided with the same numerals.

The following description applies to all Figures and embodiments, unless express reference is made to the differences.

A water meter **1** comprises a housing **4**, which is upwardly closed, toward the viewing side, by an inspection window **3**, and sealed by an annular seal or gasket **5**. The housing **4** is flooded in water. The housing **4** accommodates a counting mechanism **2**. This counting mechanism connects to measuring wheels (not shown) of the water meter. The inspection window is [realized as] in the form of an optical lens, and designed and constructed such that it makes [well] readily visible, in particular visible by enlargement, [on the one hand] the number (count, consumption value) shown on the display (counting mechanism), and that it compensates [on the other hand,] for optical distortions, which arise due to the fact that the counting mechanism is immersed in water. Furthermore, the water meter **1** comprises an identification mark **12** shown by the number 4711. This identification mark is assigned to the water meter and its location, for example, a certain water consuming point. The identification mark (meter number) is used to be able to allocate the consumption value of a certain consuming point, which is read on the counting mechanism (display [2] **2**), to a certain consuming point, and, [--] last but not least, [--] to write a bill to a certain person.

The identification mark **12** is arranged on an identification sign, which cannot be removed, altered, or damaged from the outside. In the illustrated embodiment, the identification sign is likewise arranged in the water-flooded housing such that the identification mark **12** appears parallel to and in the vicinity of the

consumption value shown on the counting mechanism, and that it can be simultaneously read with same.

The following applies to the embodiment of Figures 1 and 2:

Above the inspection window, the edge of the housing mounts guide rails **6.1, 6.2, 6.3**. Each pair of guide rails **6.1** and **6.2** is associated to the consumption value shown on the counting mechanism, and a further pair of guide rails **6.2** and **6.3** is associated to the identification mark **12**. The guide rails **6.1-6.3** are made as V-shaped or T-shaped sections. Above the base of these sections, an image reader **9** may be guided. To this end, cross members adjacent to the guide rails **6.1** and **6.2** and **6.2** and **6.3**, respectively, are arranged in such a spaced relationship that the image reader can be successively guided over the consumption value and over the identification mark, and in so doing record respectively the consumption value and the identification mark.

The necessary accuracy of the guidance depends on the one hand on the geometrical design of the head of image reader **9**, and on the other hand on the aperture angle of the optical system. In the embodiment, the optical system of the image reader is shown only schematically and symbolically by a lens **7** and a photosensitive receiver **8**. Such image readers are presently commercially available, and will therefore not be described in further detail.

In the embodiment of Figures 3-4, the recording of the consumption value and identification mark occur by an image reader **9**, which is realized as a camera. This camera **9** is able to record with a single adjustment the entire viewing field of the water meter **1**. By means of a guide system **6**, the camera is aligned with the viewing

field, i.e. both display **2** and identification mark **12**. The guide system **6** is a shell of a cylinder or frustum. The lower end face thereof is adapted to the outer contours of the water meter **1**, and placed on the water meter. The upper end face is adapted to the contours of the camera or attachment for lens **7**, and comprises in addition an aperture for two light sources **15** and the preceding focusing lenses. The guide system **6** may be an independent structural element, which is placed on the water meter, when needed, and which subsequently receives the camera. In this instance, it is possible to ensure the correct position, in particular the rotated position, by cooperating marks, notches, optical markings, or the like provided on the guide body on the one hand, and on the housing of the water meter or the camera on the other hand.

The guide system **6** may also be made integral with the water meter. In this instance, marks will be needed only on the pairing of the camera and guide body **6**. On the other hand, the guide body **6** may also be made integral with the camera or lens attachment. In this instance, marks are provided only on the pairing of the cylinder body and supply meter.

The following applies to all embodiments:

The optical system of the image reader **9** is adapted to the optical system of inspection window **3**; the spacing between the reading head with lens **7** on the one hand, and the inspection window **3** on the other hand; as well as the spacing between inspection window **3** and counting mechanism **2**, in such a manner that it is possible to identify in a reliable manner, even under unfavorable conditions, the respective consumption value by means of the receiver and the electronic devices not shown in further detail. This means that the optical system of

the image reader, the optical system of the inspection window, and the thereby visible counting mechanism, as well as the arrangement of guide rails **6.1-6.3** or guide body **6** must be adapted to one another.

A starting mark **13**, [--] in the present embodiment in the form of the letter A, [--] is permanently arranged before the consumption value, which appears on the counting mechanism. The image reader is programmed in such a manner that the read consumption value is always read and displayed from the starting mark **13**, irrespective of the direction, in which the image reader is moved along rails **6.1** and **6.2**.

In the same way, the identification mark **12** is provided with a starting mark, [--] in the present embodiment in the form of the letter combination NR. Likewise, this starting mark serves the purpose of putting by a corresponding programming, the image reader in a position to display the identification mark always in the correct direction. By a corresponding programming of the image reader, it is further recognized with reference to starting marks **13** and **14**, which of them is the identification mark, and which is the consumption value. Thus, it does not matter[,] whether or not the operator guides the image reader in a certain sequence, namely first over the consumption value, and then over the identification mark.

Furthermore, the type of counter can be made readable for the image reader by a marking, [--] in the present embodiment: Qnx.

In the illustrated embodiments, the image reader is provided with one or two light sources **15** and a corresponding source of energy (not shown). Through the lens **10** or a corresponding optical system, the light strikes the consumption value or the identification mark

such that it provides an always constant and optimally suitable illumination for the image reader.

Commercially available digital image readers and cameras now include program storages, or can be connected to program storages, which permit recognizing images, and which make the recognized images recognizable on a small display arranged on the image reader. Thus, the operator is in a position to read the read consumption value and the identification mark immediately. However, it is also possible to supply the read value, via a data line **11**, to a small [carryon] carry-on computer. In this computer, it is possible to convert the consumption value and the identification mark respectively into an alphanumerical signal. The computer may also store the result of previous readings as well as the owner of the consuming point. This makes it possible to convert the read data immediately into a bill to a certain person, and to issue it by means of a [therefor] suitable printer.

In the embodiment of Figures 3 and 4, it will also be possible to place the guide body **6** and the camera in a randomly rotated position on the supply meter, when the computer connected to the electronic-digital camera has a suitable software, which permits rotating the read image [--] (namely, first the read image of the consumption value and then the read image of the identification mark, if need be) [--] to such an extent that the computer is able to identify the read-in image as a sequence of alphanumerical characters. As in the case of standard character programs, this rotation may be performed by hand. However, a corresponding programming makes it also possible to perform the rotation automatically, until the correct position is reached. The computer or software is able to recognize by a corresponding marking (for example, starting mark "A"), whether or not the correct

position is reached. However, programming may also be such that the rotation is terminated[,] when the computer recognizes that one of the read characters corresponds to a stored alphanumerical character. The computer is now able to convert the image of the consumption value and identification mark into the corresponding alphanumerical characters and to then evaluate the received signals.

The computer may be connected to the image reader of the first embodiment or the camera of the second embodiment by cable, cable and plug connections, or[, however,] even by remote transmission, by radio, infrared, and the like.

The embodiment of Figures 3-4[,] makes it also possible to interconnect the camera, guide body **6**, and supply meter **1** permanently. [Such a realization,] This will be especially suitable[,] when the supply meter is located in manholes or other hard-to-access locations. In this instance, one may provide a remote control for actuating the camera and the light source[, a]. The remote control [via] can be a cable[,] or wireless, in particular via radio, ultrasound, or infrared. The output signals of the camera may then be supplied via a cable, or wireless, [-- as described --] to the computer, which is located preferably always outside of the hard-to-access location.

The embodiment of Figure 5 shows that the supply meter of this invention can also very advantageously be used in hard-to-access locations. Shown is a water meter **1**, which measures the flow through a line **17**. The line **17** is laid in an underground tunnel **16**. The tunnel is accessible through a manhole **18**, which may also measure several meters deep. In the manhole, the water meter can be accessed. As is known, the access to such manholes is hazardous, since gases may accumulate in such tunnels and

manholes, which lead to suffocation [in] of the maintenance personnel. Consequently, the reading of water meters in such locations always requires two persons.

In the illustrated embodiment, the water meter is permanently equipped with an image reader **9**, with a guide system **6** being interposed. The image reader includes a battery **21** as an energy storage. This battery is used to supply a radio set **19** and a remote releasing device **24**. Both are permanently connected to the image reader. The contact from the operator to the image reader is made, for example, via a portable radio set **20**, which is connected to a computer **22**. The computer **22** is operated via a keyboard. In this manner, it is possible to input, for example, a code number for the water meter or the image reader, and to thus establish the connection to the image reader. The remote releasing device is to be actuated by radio contact, and in this way the consumption value is read by the image reader and transmitted to the computer.

The image reader of Figure 6 permits illuminating the viewing field under the inspection window **3** of a water meter very uniformly and adapted to the conditions. In this embodiment, the guide system **6** is formed by a hollow-cylindrical holder **31**. A plurality of light emitters **27** are distributed over the inner circumference of the holder. Below the emitters is a hollow-cylindrical light ring **26**, and therebelow a reflection ring **30**. Preferably, the light ring is a transparent, at least translucent, hollow-cylindrical body of glass, Plexiglas, or the like. On the upper end face the light emitters **27** are arranged in a certain distribution. This distribution permits defining the illumination of the viewing field. The light beams penetrate the light ring

26 in the axial direction, and exit from an opposite end face **29**. In the region of this end face **29**, the light ring is shaped such that its surface faces the viewing field, and forms an annular surface in the shape of [an] a conical shell. In the holder **31**, below end face **29**, a reflection ring **30** is arranged, without impeding the light incidence from end face **29** onto the viewing field. The reflection ring **30** possesses an inner circumferential surface, which forms likewise an annular surface in the shape of a conical shell in facing relationship with the viewing field of the supply meter. However, this annular surface has a different angle of inclination. The light exiting from the end face (exit surface) **29** of the light ring with a certain inclination toward the viewing area has the advantage that the light beams strike the viewing area substantially not perpendicularly. This [allows to] prevents not only a shadow formation, but also the reflection of the light in the direction of the light ring.

Figures 9a-d are detail views of a plurality of configurations of light rings.

In the embodiment of Figure 9a, the exit surface **29** faces the inspection window such that the light beams do not reflect from this surface, but exit and, in so doing, refract, so that they strike the inspection window.

The same applies to the embodiments of Figures 9b-d. However, [in their instance,] each embodiment of Figures 9B-9D includes a reflection surface on the light ring, upon which the light beams impinge, and from which they are projected back into the light ring, so that they impinge upon the exit surface at a favorable angle. This angle is selected by the different relative positions of the reflection surface to the exit surface, which is exemplary in the [F]figures, so that the light beams

emerge from the exit surface completely though, but with a refraction directed toward the inspection window. In Figure 9d, the exit surface is additionally provided with prismatic, annular grooves, which permit further influencing of the refraction and deflection of the light beams. As regards the configuration of Figures 9c-d, it is further noteworthy that the exit surface is the lower part of the circular-cylindrical inner shell of the annular ring, which is made possible by a skillful arrangement of the reflection surface.

The inclination of the annular reflection surface of reflection ring **30** is selected such that the light beams, which emanate from the end face **29** of the light ring, and which are reflected on inspection window **3**, are again reflected on the reflection surface of reflection ring **30** to the inspection window, and then contribute to the illumination of the viewing field due to the changed angle of incidence. Figure 6 shows on the left a light beam[,] which leaves end face **29**, and is reflected by reflection on the inspection window or viewing field of the supply meter directly to the optical system **7** of the image reader. On the right side, a light beam is shown[,] which emanates from end face **29**, and is first reflected on inspection window **3** to the annular reflection surface of the reflection ring. Only then is it used for illuminating the viewing field.

As is further shown in Figure 6, but generally advantageous in all embodiments, a shutter **28** precedes the optical system with lens **7** of the image reader. Other than is usual in a camera, this shutter is arranged not between the lens and the photosensitive receiver **8**, but between the lens and the object being recorded. This shutter **28** serves the purpose of eliminating rays in the edge regions of the lens, which tend to scatter in

particular, and thus fail to produce clear images. Consequently, the shutter **28** is used to display the numerals and other characters with a high definition, and to make them recognizable.

Moreover, it will also serve this purpose[,] when light of a special color, and in particular also light of a narrow wave range, is produced (monochromatic light). To this end, the light sources on the one hand and photosensitive receivers **8** on the other hand are adapted to one another, so as to produce and receive only light of a certain wave length. Especially suited are green shades or yellow shades, in particular for water meters, since light of this wave range penetrates water especially well. Not only monochromatic light, but also polarized light have the advantage that a uniform, even refraction occurs, so that stray light is avoided with a defined adjustment of the image reader.

Yet, it cannot be avoided that the receiver registers the individual image points of the viewing field with unclear brightness values. The transitions between insignificant portions of the viewing field and the there displayed numerals and characters are flowing. With the use of a microprocessor, which forms a part of the computer or image reader, it is possible to accomplish that image points[,] which exceed a certain brightness value (white level)[,] are always displayed in white or in another way as bright, and that image points[,] which exceed a certain darkness value (gray scale value)[,] are always displayed dark, in particular in black. In this manner, it is possible to make with the use of the image reader[,] the recorded image substantially clearer than it is in reality.

As shown in the embodiment of Figure 7, it is also possible to integrate [in the supply meter with an image

reader,] a device[,] which permits monitoring the proper operation of the supply meter. To this end, water meters have control wheels[,] which are put into motion by the water flow, and whose rotation and rotational speed indicate that the water consumption is registered. Such a control wheel (impeller wheel **33**) is shown in the viewing area of the water meter of Figure 4. In the embodiment of Figure 7, this impeller wheel **33** is scanned by the light beams of a control lamp **38[**. Same], which may be [realized], for example, [as] a diode, transmitter diode, or light-emitting diode. The light-emitting diode is directed toward the rotating surface of control wheel **33**. The reflected light beams of the light-emitting diode are received by a photodetector **35**. With a focusing lens **36** and an optical filter **37**, the photodetector **35** is likewise directed to the surface of control wheel **33**. Independently of the image reader, the photodetector **35** connects to a signaling device, which measures, for example, the frequency of light fluctuations. The frequency fluctuation results from the fact that the control wheel **33** has on its scanned surface markings in a certain spaced relationship. The detected frequency is a measure for the proper operation of the supply meter.

It is useful that the light beams of the light-emitting diode **36** have a different wave length than the light sources for illuminating the viewing field during the reading of the consumption values. This avoids mutual interferences. Such monitoring functions will be especially useful[,] when the image reader is permanently installed on the supply meter. By way of a corresponding signaling, it will be possible to exchange the supply meter immediately, when a breakdown of its operation is signaled.

The device for scanning the control wheel is arranged on the previously described shutter ring, and precedes lens **7**. This arrangement in this location permits arranging the device for monitoring the control wheel in very close relationship with the viewing field. This is advantageous, since only a small intensity of light is needed, and interferences are avoided. Interferences coming from the outside[,] are prevented in particular in that the light ring and the cylindrical holder **31** surround the devices for scanning the control wheel.

The embodiments enable not only the reading of consumption values free of human errors, but also a simultaneous evaluation of the consumption value. In this connection, it will be especially advantageous[,] when the camera and/or the computer also include an electronic storage, which permits permanently storing the identification mark or customer data, and intermittently the consumption value. In this connection, it should be remarked that it will also be possible to store the identification mark invariably and permanently in the camera, when same is stationarily mounted on the supply meter. In this instance, a special identification mark is not needed on the supply meter. [Morover] Moreover, the storage of at least the last consumption value will make it possible to also compute the consumption value simultaneously with the next reading of the count. After the computation, the oldest meter count (consumption value) may be erased. This procedure makes it also possible to issue at the same time, when the count is read, a voucher, for example, a bill for the consumption to the customer, who is identified by the identification mark.

The invention makes it possible to show on a display the consumption values of the reading location. These values may then be taken over by the operator. Furthermore, it is possible to transfer the consumption values from the reading location to the storage of a computer that is carried along by the operator. After reading a plurality of supply meters, the consumption values may then be transferred to a central computer, which is in charge of the computation of the consumption, as well as the payment thereof, as well as the writing of bills.

The herewith realized advantages relate in particular to operations from reading to inputting the consumption values in the central computer.

However, a substantially more extensive streamlining is accomplished in that the [carryon] carry-on computer is also set up for storing preceding consumption values with the inclusion of the respective identification numbers. It will therefore be very advantageous[,] when the computer is also equipped with an output device, in particular a printer. This will make it possible to compute, in situ, without the aid of the central computer, the consumption and the payment therefor, and to write a bill to the respective consumer. Via telephone or other telecommunication lines, it will also be possible to debit directly the bank account of the customer by way of an online accounting of the payment for the consumption.

Likewise, the embodiment of Figure 8 shows a supply meter of the present invention, which is used in a hard-to-access location. In essence, its description corresponds to that of Figure 5. Likewise in this embodiment, the water meter is permanently equipped with an image reader **9** with an interposed guide system **6**. The

guide system **6** is a conical shell, which is placed with its lower end face in hermetically sealed relationship on the water meter, and which mounts the image reader in hermetically sealed relationship on its upper end face, thus forming a hermetically sealed unit, which prevents penetration of humidity and dirt.

The image reader is connected via a cable **11** to a display **39**. The display **39** is stationarily mounted in the upper region of a manhole or outside thereof. However, it may also be portable. In this instance, the cable mounts at its end an adapter, which can be coupled with the display. A structural unit **40**, in which the display is integrated, includes a battery **21** as an energy storage device. This battery is used to supply the image reader **9** and display **39**. The structural unit **40** further includes an adapter, in which a support **41** may be inserted such that it has an accurately defined position relative to the display **39**. A further camera (transmission camera) **42** may be mounted to the free end of support **41**. This camera is a normal camera, whose receiving carrier is however adapted to the light beams used by the display.

Figure 8a is an enlarged view of the structural unit and the transmission camera. The support can be pivoted by means of a hinge to its operating position or to the side. It is important that the support also includes a protective cylinder **47**, which surrounds in the operating position of the support the camera **42,** when installed, and protects it against extraneous light. The protective cylinder may also accommodate a filter **48**, which is adapted to the light emitted by display **39**. By means of this filter, it is possible to realize a binary conversion of the signals coming from the display, so that the transmission camera receives their light signals

only as "existing" or "nonexistent." Both the image recording device **9** and the transmission camera **42** are always identically adjusted and focused. With that, it is possible to ensure that the recordings occur always fast and always of the same quality.

The operator can activate the energy supply and the connection to the image reader **9** on the structural unit **40** by means of a switch **46**. As a result, the read data of the water meter appear on the display **39**. The display is then photographed by the transmission camera **42**. The recorded image of the display may then be digitized and directly transmitted, for example, by a portable radio set **20** to a remote computer **22**. In the illustrated embodiment, the remote computer **22**, which is not shown, is provided with a scanner. The image produced by the camera **42** is thus read into the computer, so that the computer is able to evaluate the read data of the water meter and prepare a bill for the consumption.

The structural unit, or alternatively the image recording device, may be provided with a storage and a timing device. The timing device permits reading the water meter at predetermined times, for example, at the first of each month, and storing the read data. In this case, the stored data are shown on the display **39** by activating the structural unit, and then transferred to the transmission camera.

The display is shown in Figure 8b. The display includes not only an image component, but also, within the recording range of the transmission camera, a control display **43**, in which light signals **44** are able to display the status of the counter, and/or a sequence of numerals **45** as the code number for the water meter. Likewise, these data are photographed by the transmission camera **42** and subsequently read into the computer.

In the same way as in the embodiment of Figure 6, the present embodiment also permits illuminating the viewing field under the inspection window **3** of a water meter in a very uniform manner and adapted to the conditions. The description of Figure 6 is herewith incorporated by reference.

[NOMENCLATURE

1	Water meter
2	Counting mechanism, display
3	Inspection window
4	Housing
5	Annular seal
6	Guide rail, guide system, guide body, shell
6.1	Guide rail
6.2	Guide rail
6.3	Guide rail
7	Lens
8	Recorder, photosensitive receiver
9	Image reader, camera
10	Focusing lens
11	Data line
12	Identification mark, meter number
13	Mark, starting mark, end mark
14	Starting mark of the identification mark
15	Light source
16	Tunnel
17	Line, water line
18	Manhole
19	Radio set
20	Radio set
21	Energy storage, battery
22	Computer
23	Adapter for connection to central computer
24	Radio controlled remote releasing device
25	Keyboard
26	Light ring
27	Light emitter
28	Shutter

29 End face
30 Reflection ring
31 Holder
32 Guide attachment
33 Impeller wheel, control wheel
34 Lens
35 Photodetector
36 Focusing lens
37 Optical filter
38 Transmitter diode, control lamp
39 Display
40 Structural unit
41 Support
42 Transmission camera, camera
43 Control display
44 Light signals
45 Sequence of numerals
46 Switch
47 Protective cylinder
48 Filter
49 Exit surface
50 Reflection surface
51 Prismatic grooves]

IN THE UNITED STATES DESIGNATED OFFICE (DO/US)

In re:	Schröter	Attn: DO/US
International Appl. No.:	PCT/EP00/04043	
International Filing Date:	May 6, 2000	
For:	SUPPLY METER AND METHOD FOR READING A FIXED SUPPLY METER	

November 9, 2001

Box PCT
Commissioner for Patents
Washington, DC 20231

PRELIMINARY AMENDMENT

Sir:

Please amend the above-identified application as follows:

In The Claims:

Please amend Claims 3, 4, 8-20, and 24 as follows:

3. (Amended) Supply meter of claim 1,
characterized in that
the guide system is a frame adapted to the meter in the region of the viewing area and placed thereon, the other end of which mounts or is adapted to receive the image reader (9) that is realized as a camera, and which produces a predetermined spacing between the camera (9) and the viewing area of the supply meter, as well as an alignment of the optical system of the camera with the viewing field.

4. (Amended) Supply meter of claim 1,
characterized in that
the image reader connects to a light source for illuminating the display of a consumption value and/or an identification mark, the light source being preferably mounted to the camera or to the guide system.

8. (Amended) Supply meter of claim 6,

characterized in that
the exit surface (49) of the light ring is provided with annular grooves with a prismatic axial section for refracting the exiting light beams in the direction of the viewing surface or inspection window of the supply meter.

9. (Amended) Supply meter of claim 1, characterized in that
between the light ring and the inspection window of the supply meter, a reflector ring is arranged in concentric relationship with the light ring, the reflector ring having a conical reflector surface in facing relationship with the inspection window, which preferably reflects the light beams emerging from the exit surface, and/or the light beams being reflected from the viewing area or inspection window, onto the viewing area or inspection window, with the reflector ring serving preferably at least as a part of the guide system.

10. (Amended) Supply meter of claim 4,
characterized in that
the light emitters have a substantially monochromatic light or light of a limited wave range, in particular in the green or yellow range.

11. (Amended) Supply meter of claim 1,
characterized in that
the supply meter is a water meter (water counter), which includes an inspection window (3), through which the consumption value shown as a line of numerals or reading line can be viewed on the display (2), which is immersed in water.

12. (Amended) Supply meter of claim 1,
characterized in that
the image reader is a scanner, which includes an optical system (lens 7) as well as a receiver (8) for a point-by-point recording and storage of the image of the consumption value shown in the reading line.

13. (Amended) Supply meter of claim 1,
characterized in that
the image reader is a camera, preferably a digital camera, which includes an optical system (lens 7, receiver 8) for recording and storing the image in the viewing field of the meter.

14. (Amended) Supply meter of claim 1,
characterized in that
the image reader is connected to a comparison device as well as to a computer and software, which permit detecting at predetermined time intervals the time change of the image points of at least a partial area of the inspection window, in which a control wheel with markings or another moved surface with markings is arranged, whose moving speed depends on the function of the supply meter and preferably on the amount of consumption.

15. (Amended) Supply meter of claim 1,
characterized in that
the image reader includes a photosensitive photodetector, which is directed toward a control wheel with markings located in the inspection window, or another movable surface with markings, and a microprocessor connected thereto, which determines the frequency of the light pulses generated by the markings, and that the moving speed of the control wheel or surface depends on the function of the supply meter and preferably on the amount of consumption.

16. (Amended) Supply meter of claim 13,
characterized in that
the partial area is illuminated by its own light source (additional light source), whose wave length and/or polarization preferably correspond to those of the other light sources, with the photodetector being preferably preceded by an optical filter in the wave length range and/or polarization range of the additional light source associated to the photodetector.

17. (Amended) Supply meter of claim 1,
characterized in that
the supply meter (1), the image reader (9), and the guide system form above the inspection window, a hermetically sealed, watertight, and dustproof unit.

18. (Amended) Supply meter of claim 1,
characterized in that
the image reader is wireless, in particular equipped and/or connected, and/or connectible, via radio, ultrasound, an infrared transmitter/infrared receiver, or via a cable to a computer with a program storage and a program for an alphanumerical evaluation of the read-in images.

19. (Amended) Supply meter of claim 1,
characterized in that
the image reader (9) is provided with a data storage for storing the read-in images and data, as well as with a time-dependent switch and/or an electronic remote control, which permit activating the image reader (9) and preferably likewise the illumination of the viewing area of the meter for reading the actual data of the supply meter.

20. (Amended) Supply meter of claim 1,
characterized in that
the image reader is adapted for being connected, or is permanently connected via a cable to a display (39), and that the display comprises a support (41), to which a camera (transmission camera 42) is to be mounted in a predetermined position above the display for recording the data shown on the display.

24. Method of claim 22,
characterized in that
the storage of the data occurs in a computer, which is associated in spatially close relationship to the image reader of the supply meter, and which includes preferably plug connections or other

connection elements for connecting to a central computer and/or to communication networks, in particular for carrying out a money transfer by means of remote debiting.

REMARKS

The foregoing amendments remove multiple dependencies. Please enter the foregoing amendments prior to calculating the claim fees.

Respectfully submitted,

James A. Witherspoon
Registration No. 36,723

ALSTON & BIRD LLP
Bank of America Plaza
101 South Tryon Street, Suite 4000
Charlotte, NC 28280-4000
Tel Charlotte Office (704) 444-1000
Fax Charlotte Office (704) 444-1111
Customer No. 00826
#4505946v1

CERTIFICATE OF EXPRESS MAILING

"Express Mail" mailing label number EL 913134748 US
Date of Deposit November 9, 2001

I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to Box PCT, Commissioner For Patents, Washington, DC 20231.

Joyce D. Smith

Version With Markings to Show Changes Made:

Claims 3, 4, 8-20, and 24 have been amended as follows:

3. (Amended) Supply meter of claim 1 [or 2],
characterized in that
the guide system is a frame adapted to the meter in the region of the viewing area and placed thereon, the other end of which mounts or is adapted to receive the image reader (9) that is realized as a camera, and which produces a predetermined spacing between the camera (9) and the viewing area of the supply meter, as well as an alignment of the optical system of the camera with the viewing field.

4. (Amended) Supply meter of [one of the foregoing claims] claim 1,
characterized in that
the image reader connects to a light source for illuminating the display of a consumption value and/or an identification mark, the light source being preferably mounted to the camera or to the guide system.

8. (Amended) Supply meter of claim 6 [or 7],
characterized in that
the exit surface (49) of the light ring is provided with annular grooves with a prismatic axial section for refracting the exiting light beams in the direction of the viewing surface or inspection window of the supply meter.

9. (Amended) Supply meter of [one of claims 1-8] claim 1, characterized in that between the light ring and the inspection window of the supply meter, a reflector ring is arranged in concentric relationship with the light ring, the reflector ring having a conical reflector surface in facing relationship with the inspection window, which preferably reflects the light beams emerging from the exit surface, and/or the light beams being reflected from the viewing area or inspection window, onto the viewing area or inspection window, with the reflector ring serving preferably at least as a part of the guide system.

10. (Amended) Supply meter of [one of claims 4-9] claim 4,
characterized in that
the light emitters have a substantially monochromatic light or light of a limited wave range, in particular in the green or yellow range.

11. (Amended) Supply meter of [one of the foregoing claims] claim 1,
characterized in that
the supply meter is a water meter (water counter), which includes an inspection window (3), through which the consumption value shown as a line of numerals or reading line can be viewed on the display (2), which is immersed in water.

12. (Amended) Supply meter of [one of the foregoing claims] claim 1,
characterized in that
the image reader is a scanner, which includes an optical system (lens 7) as well as a receiver (8) for a point-by-point recording and storage of the image of the consumption value shown in the reading line.

13. (Amended) Supply meter of [one of claims 1-12] claim 1,
characterized in that
the image reader is a camera, preferably a digital camera, which includes an optical system (lens 7, receiver 8) for recording and storing the image in the viewing field of the meter.

14. (Amended) Supply meter of [one of claims 1-12] claim 1,
characterized in that
the image reader is connected to a comparison device as well as to a computer and software, which permit detecting at predetermined time intervals the time change of the image points of at least a partial area of the inspection window, in which a control wheel with markings or another moved surface with markings is arranged, whose moving speed depends on the function of the

supply meter and preferably on the amount of consumption.

15. (Amended) Supply meter of [one of claims 1-13] claim 1,
characterized in that
the image reader includes a photosensitive photodetector, which is directed toward a control wheel with markings located in the inspection window, or another movable surface with markings, and a microprocessor connected thereto, which determines the frequency of the light pulses generated by the markings, and that the moving speed of the control wheel or surface depends on the function of the supply meter and preferably on the amount of consumption.

16. (Amended) Supply meter of claim 13 [or 14],
characterized in that
the partial area is illuminated by its own light source (additional light source), whose wave length and/or polarization preferably correspond to those of the other light sources, with the photodetector being preferably preceded by an optical filter in the wave length range and/or polarization range of the additional light source associated to the photodetector.

17. (Amended) Supply meter of [one of the foregoing claims] claim 1,
characterized in that
the supply meter (1), the image reader (9), and the guide system form above the inspection window, a hermetically sealed, watertight, and dustproof unit.

18. (Amended) Supply meter of [one of the foregoing claims] claim 1,
characterized in that
the image reader is wireless, in particular equipped and/or connected, and/or connectible, via radio, ultrasound, an infrared transmitter/infrared receiver, or via a cable to a computer with a program storage and a program for an alphanumerical evaluation of the read-in images.

19. (Amended) Supply meter of [one of the foregoing claims] claim 1,

characterized in that

the image reader (9) is provided with a data storage for storing the read-in images and data, as well as with a time-dependent switch and/or an electronic remote control, which permit activating the image reader (9) and preferably likewise the illumination of the viewing area of the meter for reading the actual data of the supply meter.

20. (Amended) Supply meter of [one of the foregoing claims] claim 1,

characterized in that

the image reader is adapted for being connected, or is permanently connected via a cable to a display (39), and that the display comprises a support (41), to which a camera (transmission camera 42) is to be mounted in a predetermined position above the display for recording the data shown on the display.

24. Method of claim 22 [or 23],

characterized in that

the storage of the data occurs in a computer, which is associated in spatially close relationship to the image reader of the supply meter, and which includes preferably plug connections or other connection elements for connecting to a central computer and/or to communication networks, in particular for carrying out a money transfer by means of remote debiting.

SUPPLY METER AND METHOD FOR READING A FIXED SUPPLY METER

The invention relates to a supply meter as defined in the preamble of claim 1, and a method of reading a stationary supply meter as defined in the preamble of claim 22.

Supply meters are generally known and used for measuring, for example, the consumption of water.

To determine the consumption, supply meters of this kind require an optical reading of numerals "by hand," and associating them to a consumer or a household. Since supply meters are rarely arranged in a place that is favorable for reading, the reading is time-consuming, at times very difficult, and even affected by unreliability.

It is an object of the invention to improve the supply meter and the method of reading the supply meter such that it is possible to determine the value of consumption in a simple, fast, reliable, and in particular independent manner from the local environmental situation of the supply meter.

The solution results respectively from claim 1 and claim 22.

The solution has the advantage that it permits a cost-favorable determination of the value of consumption. Likewise, without further activity by a person, it is possible to further process with the use of the data technology, the determined consumption values by an electronic computer, as well as to determine the consumption and to prepare the bill for the consumption automatically. The invention makes it possible to use by means of a suitable mechanical and optical adaptation, commercially available image readers for determining the consumption, thereby eliminating human sources of error.

A person may guide such image readers by hand. In this case, the reading head of these image readers has essentially the size of a hand (see, VDI Nachrichten, No. 12, March 26, 1999).

The intended guide system of the image reader, permits arranging the image reader, in particular a digital camera, above the display window of the supply meter such that it is possible recognize fully and read simultaneously all numerals of the consumption rate or other characters and marks being read from the display window, such as in particular an identification number, which is assigned to each consumer or household.

The guide system that is provided to this end, may be, for example, a template placed on the image reader, in which the image reader is arranged or laterally movable -- depending on the size of the detection range of the image reader. The template is adapted to the supply meter such that it can be placed on the supply meter only in very specific positions, and that, as a result, the image reader is arranged above the inspection window of the supply meter only in a very specific direction, or that it can be guided over the inspection window of the image reader.

Thus, the invention proceeds from the recognition that a reliable reading and errorless recognition of the numerals and characters appearing in the inspection window of the supply meter will be ensured with the use of a digital image reader only, when the image reader is adapted in an optimal manner, by means of an adapted guide system in a defined position with an always identical display field, to the sizes, colors, and contrasts, and other visual conditions, as well as to light conditions.

The development of claim 2 accomplishes that even in the case of conventional supply meters, it is possible to produce the combination of supply meter, guide system, and image reader, which is necessary for the reading operation. In this connection, the guide system may be mounted to the image reader. It is not necessary that a guide system be rigidly arranged on each supply meter.

For example, the guide system may be guide rails, which are arranged above the inspection window of the supply meter. In this instance, the reading head of the image reader is designed and constructed such that it is guided in or on the guide rails in a certain direction and position.

The further development of claim 3 has the advantage that the reading operation becomes largely independent of human influence and corresponding human sources of error. The viewing field is recorded as a whole in a single exposure step. The association of the read value of consumption to a certain household occurs in that besides the consumption value, all other data, which are needed for determining the consumption of a certain household or consumer, are recorded via optical systems and, if need be, with the use of data systems, and that they are electronically stored. This also includes identification marks, which are arranged on the meter in a tamperproof manner.

The optical systems of such image readers may very made highly photosensitive, so that it is possible to read at least the consumption values or identification marks in existing daylight or artificial light. In the advantageous development of claim 4, the reading reliability and reading accuracy are independent of environmental conditions and in particular of light conditions.

The development of claim 5 distinguishes itself in that it permits a very uniform illumination, thereby ensuring readability and recognizability of the characters being read from the inspection window. Corresponding arrangements of the light emitters on the annular end face of the light ring make it possible to adjust the illumination of the viewing area according to requirements.

It is of special importance that the light beams be directed toward the supply meter, which has an inspection window that covers the viewing area, in such a manner that the light beams are not reflected on the inspection window. This is accomplished by a corresponding configuration of the light rings in accordance with the development of claims 6, 7, and 8. With that, it is avoided that light beams that are reflected on the inspection window, return to the image reader, and are wrongly interpreted by the image reader.

Likewise the development of claim 9 is used for avoiding reflections.

In the developments of claims 5-9, is its possible to omit a special guide system. Instead, they propose to use preferably the light ring, and/or the reflector ring as a guide system or at least as a part thereof.

For the recognizability of the numerals and other characters being read, it will be of special advantage, when the image reader and light emitter or light sources are adapted to one another in accordance with claim 10. In this instance, one may select wave lengths of the light, which are especially low in reflection.

The invention finds an especially advantageous use in the development of claim 11, since water meters are often arranged in very unfavorable locations.

In comparison with supply meters of other media, a water meter has the unique characteristic that the counting mechanism and numerical scale are immersed in water. While, this requires a special adaptation of the optical system, it also has the advantage that the counting mechanism is not susceptible to contamination. This also applies to the identification mark, even when same is under the inspection window. In this instance, the inspection window may be constructed as a lens, primarily a weak lens, for purposes of improving the recognizability of numerals and other characters.

As aforesaid, the invention has the advantage that is also permits, via data systems, a further processing of the recorded consumption values or identification marks, since the image reader in its current marketable design first records the determined numerals only as an image, but in digitized form. For the correct recognition and display of these images, and for the conversion of these images into alphanumerical characters, special marks of the lines may be used, in which the values being read are located. For converting the images into alphanumerical characters, an OCR (optical character recognition) software is used.

The image reader, which is used within the scope of the present invention, is preferably a digital camera (claim 12). It may also be a laser scanner, which scans the viewing area line by line in a predetermined and controlled sequence, with the light value of the recorded image points being stored in a reproducible manner (claim 11).

The currently marketed image readers make it possible to show the read data on a display, so that the operator is able to enter the recorded data by hand into a written document, provided one of the developments

defined in claims 1-13 has been met at least in a manner corresponding to the respective requirements.

One may avoid optical errors, inaccuracies, or ambiguities of the image design by the image reader, and produce a clearly black and white image of the viewing area, in that the image reader is connected to a computer, which clearly allocates each image point of the viewing area to a binary signal (black or white). Such a display has a definition, which is not realizable with merely optical means.

The use of a digital camera also has the advantage that when reading a display, the recording element of the camera shows the correct position. As a result of connecting the image reader to a computer, it is however also possible to rotate the viewing area automatically during the reading, so as to enable a reading "by hand" and/or a comparison of the recorded characters with characters that are predetermined and stored in the computer. Likewise, by engaging the image reader and the guide system on the supply meter, it is possible to predetermine that the image reader has the correct alignment with the viewing area.

To be able to monitor the operation of the supply meter likewise over a long period of time with little energy consumption, as well as for the safety and reliability of this monitoring, the developments of claim 14 or in particular claim 15 are proposed. According to claim 16, this monitoring system is designed such that is does not adversely affect the reading of the consumption.

If an operator continues to read the supply meters, the reading will be simplified by the invention, and be made more reliable. However, it is also possible to include in the reading step, operations that have so far had to occur subsequently by evaluating the read values.

The development of claim 18 enables via data systems the processing of the recorded consumption values and identification marks up to and including an automatic writing of bills.

In many cases, supply meters are arranged in inaccessible locations, for example, in chemical plants or manholes. In these cases, the reading of the consumption values is not only difficult, but also connected with hazards. A stationary installation of the image reader and the guide system on the supply meter, and the connection of the image reader to an associated computer permit eliminating this problem, in particular in the development of claims 18, 19, 20, and 21.

With its different developments, the invention also enables a variable realization of the reading method. In this connection, different steps of automation are possible. However, the object is also a continuous automation, including the evaluation of the consumption values and, if need be, preparation of bills. This object is met by the method of claim 22 with the variations of claims 23 and 24.

In the following, the invention is described with reference to embodiments.

In the drawing:

Figure 1 is a view of a water meter;

Figure 2 is a partially sectioned view of a water meter with a sectional view of an image reader;

Figure 3 is a partially sectioned view of a water meter with a sectional view of a camera;

Figure 4 is a view of a water meter of Figure 3;

Figure 5 is a cross sectional view of a supply meter with remote data transmission;

Figure 6 is a cross sectional view of the optical system, the light ring, and the supply meter of an embodiment (partial);

Figure 7 is a sectional view of an image reader, guide system, and consumption body with an additional light source, and a supply meter with a control wheel;

Figures 8, 8a-b show the reading of consumption values, which result in a manhole; and

Figure 9 is a detail view of the image readers of Figures 6 and 8.

The devices illustrated in Figures 1-9 are largely identical. In the following description, parts of identical function are provided with the same numerals. The following description applies to all Figures and embodiments, unless express reference is made to the differences.

A water meter **1** comprises a housing **4**, which is upwardly closed, toward the viewing side, by an inspection window **3**, and sealed by an annular gasket **5**. The housing **4** is flooded in water. The housing **4** accommodates a counting mechanism **2**. This counting mechanism connects to measuring wheels (not shown) of the water meter. The inspection window is realized as an optical lens, and designed and constructed such that it makes well visible, in particular visible by enlargement, on the one hand the number (count, consumption value) shown on the display (counting mechanism), and that it compensates on the other hand, optical distortions, which arise due to the fact that the counting mechanism is immersed in water. Furthermore, the water meter **1** comprises an identification mark **12** shown by the number 4711. This identification mark is assigned to the water meter and its location, for example, a certain water consuming point. The identification mark (meter number)

is used to be able to allocate the consumption value of a certain consuming point, which is read on the counting mechanism (display 2), to a certain consuming point, and -- last but not least -- to write a bill to a certain person.

The identification mark **12** is arranged on an identification sign, which cannot be removed, altered, or damaged from the outside. In the illustrated embodiment, the identification sign is likewise arranged in the water-flooded housing such that the identification mark **12** appears parallel to and in the vicinity of the consumption value shown on the counting mechanism, and that it can be simultaneously read with same.

The following applies to the embodiment of Figures 1 and 2:

Above the inspection window, the edge of the housing mounts guide rails **6.1, 6.2, 6.3**. Each pair of guide rails **6.1** and **6.2** is associated to the consumption value shown on the counting mechanism, and a further pair of guide rails **6.2** and **6.3** is associated to the identification mark **12**. The guide rails **6.1-6.3** are made as V-shaped or T-shaped sections. Above the base of these sections, an image reader **9** may be guided. To this end, cross members adjacent to the guide rails **6.1** and **6.2** and **6.2** and **6.3**, respectively, are arranged in such a spaced relationship that the image reader can be successively guided over the consumption value and over the identification mark, and in so doing record respectively the consumption value and the identification mark.

The necessary accuracy of the guidance depends on the one hand on the geometrical design of the head of image reader **9**, and on the other hand on the aperture angle of the optical system. In the embodiment, the

optical system of the image reader is shown only schematically and symbolically by a lens **7** and a photosensitive receiver **8**. Such image readers are presently commercially available, and will therefore not be described in further detail.

In the embodiment of Figures 3-4, the recording of the consumption value and identification mark occur by an image reader **9**, which is realized as a camera. This camera **9** is able to record with a single adjustment the entire viewing field of the water meter **1**. By means of a guide system **6**, the camera is aligned with the viewing field, i.e. both display **2** and identification mark **12**. The guide system **6** is a shell of a cylinder or frustum. The lower end face thereof is adapted to the outer contours of the water meter **1**, and placed on the water meter. The upper end face is adapted to the contours of the camera or attachment for lens **7**, and comprises in addition an aperture for two light sources **15** and the preceding focusing lenses. The guide system **6** may be an independent structural element, which is placed on the water meter, when needed, and which subsequently receives the camera. In this instance, it is possible to ensure the correct position, in particular the rotated position, by cooperating marks, notches, optical markings, or the like provided on the guide body on the one hand, and on the housing of the water meter or the camera on the other hand.

The guide system **6** may also be made integral with the water meter. In this instance, marks will be needed only on the pairing of the camera and guide body **6**. On the other hand, the guide body **6** may also be made integral with the camera or lens attachment. In this instance, marks are provided only on the pairing of the cylinder body and supply meter.

The following applies to all embodiments:

The optical system of the image reader **9** is adapted to

the optical system of inspection window **3**;

the spacing between the reading head with lens **7** on the one hand, and the inspection window **3** on the other hand; as well as

the spacing between inspection window **3** and counting mechanism **2**,

in such a manner that it is possible to identify in a reliable manner, even under unfavorable conditions, the respective consumption value by means of the receiver and the electronic devices not shown in further detail. This means that the optical system of the image reader, the optical system of the inspection window, and the thereby visible counting mechanism, as well as the arrangement of guide rails **6.1-6.3** or guide body **6** must be adapted to one another.

A starting mark **13** -- in the present embodiment in the form of the letter A -- is permanently arranged before the consumption value, which appears on the counting mechanism. The image reader is programmed in such a manner that the read consumption value is always read and displayed from the starting mark **13**, irrespective of the direction, in which the image reader is moved along rails **6.1** and **6.2**.

In the same way, the identification mark **12** is provided with a starting mark -- in the present embodiment in the form of the letter combination NR. Likewise, this starting mark serves the purpose of putting by a corresponding programming, the image reader in a position to display the identification mark always in the correct direction. By a corresponding programming of the image reader, it is further recognized with

reference to starting marks **13** and **14**, which of them is the identification mark, and which is the consumption value. Thus, it does not matter, whether or not the operator guides the image reader in a certain sequence, namely first over the consumption value, and then over the identification mark.

Furthermore, the type of counter can be made readable for the image reader by a marking -- in the present embodiment: Qnx.

In the illustrated embodiments, the image reader is provided with one or two light sources **15** and a corresponding source of energy not shown. Through the lens **10** or a corresponding optical system, the light strikes the consumption value or the identification mark such that it provides an always constant and optimally suitable illumination for the image reader.

Commercially available digital image readers and cameras now include program storages, or can be connected to program storages, which permit recognizing images, and which make the recognized images recognizable on a small display arranged on the image reader. Thus, the operator is in a position to read the read consumption value and the identification mark immediately. However, it is also possible to supply the read value, via a data line **11**, to a small carryon computer. In this computer, it is possible to convert the consumption value and the identification mark respectively into an alphanumerical signal. The computer may also store the result of previous readings as well as the owner of the consuming point. This makes it possible to convert the read data immediately into a bill to a certain person, and to issue it by means of a therefor suitable printer.

In the embodiment of Figures 3 and 4, it will also be possible to place the guide body **6** and the camera in a

randomly rotated position on the supply meter, when the computer connected to the electronic-digital camera has a suitable software, which permits rotating the read image -- namely, first the read image of the consumption value and then the read image of the identification mark, if need be -- to such an extent that the computer is able to identify the read-in image as a sequence of alphanumerical characters. As in the case of standard character programs, this rotation may be performed by hand. However, a corresponding programming makes it also possible to perform the rotation automatically, until the correct position is reached. The computer or software is able to recognize by a corresponding marking (for example, starting mark "A"), whether or not the correct position is reached. However, programming may also be such that the rotation is terminated, when the computer recognizes that one of the read characters corresponds to a stored alphanumerical character. The computer is now able to convert the image of the consumption value and identification mark into the corresponding alphanumerical characters and to then evaluate the received signals.

The computer may be connected to the image reader of the first embodiment or the camera of the second embodiment by cable, cable and plug connections, or, however, even by remote transmission, by radio, infrared, and the like.

The embodiment of Figures 3-4, makes it also possible to interconnect the camera, guide body **6**, and supply meter **1** permanently. Such a realization, will be especially suitable, when the supply meter is located in manholes or other hard-to-access locations. In this instance, one may provide for actuating the camera and the light source, a remote control via a cable, or wireless, in particular via radio, ultrasound, or

infrared. The output signals of the camera may then be supplied via a cable, or wireless -- as described -- to the computer, which is located preferably always outside of the hard-to-access location.

The embodiment of Figure 5 shows that the supply meter of this invention can also very advantageously be used in hard-to-access locations. Shown is a water meter **1**, which measures the flow through a line **17**. The line **17** is laid in an underground tunnel **16**. The tunnel is accessible through a manhole **18**, which may also measure several meters deep. In the manhole, the water meter can be accessed. As is known, the access to such manholes is hazardous, since gases may accumulate in such tunnels and manholes, which lead to suffocation in the maintenance personnel. Consequently, the reading of water meters in such locations always requires two persons.

In the illustrated embodiment, the water meter is permanently equipped with an image reader **9**, with a guide system **6** being interposed. The image reader includes a battery **21** as an energy storage. This battery is used to supply a radio set **19** and a remote releasing device **24**. Both are permanently connected to the image reader. The contact from the operator to the image reader is made, for example, via a portable radio set **20**, which is connected to a computer **22**. The computer **22** is operated via a keyboard. In this manner, it is possible to input, for example, a code number for the water meter or the image reader, and to thus establish the connection to the image reader. The remote releasing device is to be actuated by radio contact, and in this way the consumption value is read by the image reader and transmitted to the computer.

The image reader of Figure 6 permits illuminating the viewing field under the inspection window **3** of a

water meter very uniformly and adapted to the conditions. In this embodiment, the guide system **6** is formed by a hollow-cylindrical holder **31**. A plurality of light emitters **27** are distributed over the inner circumference of the holder. Below the emitters is a hollow-cylindrical light ring **26**, and therebelow a reflection ring **30**. Preferably, the light ring is a transparent, at least translucent, hollow-cylindrical body of glass, Plexiglas, or the like. On the upper end face the light emitters **27** are arranged in a certain distribution. This distribution permits defining the illumination of the viewing field. The light beams penetrate the light ring **26** in the axial direction, and exit from an opposite end face **29**. In the region of this end face **29**, the light ring is shaped such that its surface faces the viewing field, and forms an annular surface in the shape of an conical shell. In the holder **31**, below end face **29**, a reflection ring **30** is arranged, without impeding the light incidence from end face **29** onto the viewing field. The reflection ring **30** possesses an inner circumferential surface, which forms likewise an annular surface in the shape of a conical shell in facing relationship with the viewing field of the supply meter. However, this annular surface has a different angle of inclination. The light exit from the end face (exit surface) **29** of the light ring with a certain inclination toward the viewing area has the advantage that the light beams strike the viewing area substantially not perpendicularly. This allows to prevent not only a shadow formation, but also the reflection of the light in the direction of the light ring.

Figures 9a-d are detail views of a plurality of configurations of light rings.

In the embodiment of Figure 9a, the exit surface **29** faces the inspection window such that the light beams do not reflect from this surface, but exit and, in so doing, refract, so that they strike the inspection window.

The same applies to the embodiments of Figures 9b-d. However, in their instance, each embodiment includes a reflection surface on the light ring, upon which the light beams impinge, and from which they are projected back into the light ring, so that they impinge upon the exit surface at a favorable angle. This angle is selected by the different relative positions of the reflection surface to the exit surface, which is exemplary in the Figures, so that the light beams emerge from the exit surface completely though, but with a refraction directed toward the inspection window. In Figure 9d, the exit surface is additionally provided with prismatic, annular grooves, which permit further influencing the refraction and deflection of the light beams. As regards the configuration of Figures 9c-d, it is further noteworthy that the exit surface is the lower part of the circular-cylindrical inner shell of the annular ring, which is made possible by a skillful arrangement of the reflection surface.

The inclination of the annular reflection surface of reflection ring **30** is selected such that the light beams, which emanate from the end face **29** of the light ring, and which are reflected on inspection window **3**, are again reflected on the reflection surface of reflection ring **30** to the inspection window, and then contribute to the illumination of the viewing field due to the changed angle of incidence. Figure 6 shows on the left a light beam, which leaves end face **29**, and is reflected by reflection on the inspection window or viewing field of the supply meter directly to the optical system **7** of the

image reader. On the right side, a light beam is shown, which emanates from end face **29**, and is first reflected on inspection window **3** to the annular reflection surface of the reflection ring. Only then is it used for illuminating the viewing field.

As is further shown in Figure 6, but generally advantageous in all embodiments, a shutter **28** precedes the optical system with lens **7** of the image reader. Other than is usual in a camera, this shutter is arranged not between the lens and the photosensitive receiver **8**, but between the lens and the object being recorded. This shutter **28** serves the purpose of eliminating rays in the edge regions of the lens, which tend to scatter in particular, and thus fail to produce clear images. Consequently, the shutter **28** is used to display the numerals and other characters with a high definition, and to make them recognizable.

Moreover, it will also serve this purpose, when light of a special color, and in particular also light of a narrow wave range is produced (monochromatic light). To this end, the light sources on the one hand and photosensitive receivers **8** on the other hand are adapted to one another, so as to produce and receive only light of a certain wave length. Especially suited are green shades or yellow shades, in particular for water meters, since light of this wave range penetrates water especially well. Not only monochromatic light, but also polarized light have the advantage that a uniform, even refraction occurs, so that stray light is avoided with a defined adjustment of the image reader.

Yet, it cannot be avoided that the receiver registers the individual image points of the viewing field with unclear brightness values. The transitions between insignificant portions of the viewing field and

the there displayed numerals and characters are flowing. With the use of a microprocessor, which forms a part of the computer or image reader, it is possible to accomplish that image points, which exceed a certain brightness value (white level), are always displayed in white or in another way as bright, and that image points, which exceed a certain darkness value (gray scale value), are always displayed dark, in particular in black. In this manner, it is possible to make with the use of the image reader, the recorded image substantially clearer than it is in reality.

As shown in the embodiment of Figure 7, it is also possible to integrate in the supply meter with an image reader, a device, which permits monitoring the proper operation of the supply meter. To this end, water meters have control wheels, which are put into motion by the water flow, and whose rotation and rotational speed indicate that the water consumption is registered. Such a control wheel (impeller wheel **33**) is shown in the viewing area of the water meter of Figure 4. In the embodiment of Figure 7, this impeller wheel **33** is scanned by the light beams of a control lamp **38**. Same may be realized, for example, as a diode, transmitter diode, or light-emitting diode. The light-emitting diode is directed toward the rotating surface of control wheel **33**. The reflected light beams of the light-emitting diode are received by a photodetector **35**. With a focusing lens **36** and an optical filter **37**, the photodetector **35** is likewise directed to the surface of control wheel **33**. Independently of the image reader, the photodetector **35** connects to a signaling device, which measures, for example, the frequency of light fluctuations. The frequency fluctuation results from the fact that the control wheel **33** has on its scanned surface markings in a

certain spaced relationship. The detected frequency is a measure for the proper operation of the supply meter.

It is useful that the light beams of the light-emitting diode **36** have a different wave length than the light sources for illuminating the viewing field during the reading of the consumption values. This avoids mutual interferences. Such monitoring functions will be especially useful, when the image reader is permanently installed on the supply meter. By way of a corresponding signaling, it will be possible to exchange the supply meter immediately, when a breakdown of its operation is signaled.

The device for scanning the control wheel is arranged on the previously described shutter ring, and precedes lens **7**. This arrangement in this location permits arranging the device for monitoring the control wheel in very close relationship with the viewing field. This is advantageous, since only a small intensity of light is needed, and interferences are avoided. Interferences coming from the outside, are prevented in particular in that the light ring and the cylindrical holder **31** surround the devices for scanning the control wheel.

The embodiments enable not only the reading of consumption values free of human errors, but also a simultaneous evaluation of the consumption value. In this connection, it will be especially advantageous, when the camera and/or the computer also include an electronic storage, which permits permanently storing the identification mark or customer data, and intermittently the consumption value. In this connection, it should be remarked that it will also be possible to store the identification mark invariably and permanently in the camera, when same is stationarily mounted on the supply

meter. In this instance, a special identification mark is not needed on the supply meter. Morover, the storage of at least the last consumption value will make it possible to also compute the consumption value simultaneously with the next reading of the count. After the computation, the oldest meter count (consumption value) may be erased. This procedure makes it also possible to issue at the same time, when the count is read, a voucher, for example, a bill for the consumption to the customer, who is identified by the identification mark.

The invention makes it possible to show on a display the consumption values of the reading location. These values may then be taken over by the operator. Furthermore, it is possible to transfer the consumption values from the reading location to the storage of a computer that is carried along by the operator. After reading a plurality of supply meters, the consumption values may then be transferred to a central computer, which is in charge of the computation of the consumption, as well as the payment thereof, as well as the writing of bills.

The herewith realized advantages relate in particular to operations from reading to inputting the consumption values in the central computer.

However, a substantially more extensive streamlining is accomplished in that the carryon computer is also set up for storing preceding consumption values with the inclusion of the respective identification numbers. It will therefore be very advantageous, when the computer is also equipped with an output device, in particular a printer. This will make it possible to compute, in situ, without the aid of the central computer, the consumption and the payment therefor, and to write a bill to the

respective consumer. Via telephone or other telecommunication lines, it will also be possible to debit directly the bank account of the customer by way of an online accounting of the payment for the consumption.

Likewise, the embodiment of Figure 8 shows a supply meter of the present invention, which is used in a hard-to-access location. In essence, its description corresponds to that of Figure 5. Likewise in this embodiment, the water meter is permanently equipped with an image reader **9** with an interposed guide system **6**. The guide system **6** is a conical shell, which is placed with its lower end face in hermetically sealed relationship on the water meter, and which mounts the image reader in hermetically sealed relationship on its upper end face, thus forming a hermetically sealed unit, which prevents penetration of humidity and dirt.

The image reader is connected via a cable **11** to a display **39**. The display **39** is stationarily mounted in the upper region of a manhole or outside thereof. However, it may also be portable. In this instance, the cable mounts at its end an adapter, which can be coupled with the display. A structural unit **40**, in which the display is integrated, includes a battery **21** as an energy storage. This battery is used to supply the image reader **9** and display **39**. The structural unit **40** further includes an adapter, in which a support **41** may be inserted such that it has an accurately defined position relative to the display **39**. A further camera (transmission camera) **42** may be mounted to the free end of support **41**. This camera is a normal camera, whose receiving carrier is however adapted to the light beams used by the display.

Figure 8a is an enlarged view of the structural unit and the transmission camera. The support can be pivoted

by means of a hinge to its operating position or to the side. It is important that the support also include a protective cylinder **47**, which surrounds in the operating position of the support the camera **42**, when installed, and protects it against extraneous light. The protective cylinder may also accommodate a filter **48**, which is adapted to the light emitted by display **39**. By means of this filter, it is possible to realize a binary conversion of the signals coming from the display, so that the transmission camera receives their light signals only as "existing" or "nonexistent." Both the image recording device **9** and the transmission camera **42** are always identically adjusted and focused. With that, it is possible to ensure that the recordings occur always fast and always of the same quality.

The operator can activate the energy supply and the connection to the image reader **9** on the structural unit **40** by means of a switch **46**. As a result, the read data of the water meter appear on the display **39**. The display is then photographed by the transmission camera **42**. The recorded image of the display may then be digitized and directly transmitted, for example, by a portable radio set **20** to a remote computer **22**. In the illustrated embodiment, the remote computer **22**, which is not shown, is provided with a scanner. The image produced by the camera **42** is thus read into the computer, so that the computer is able to evaluate the read data of the water meter and prepare a bill for the consumption.

The structural unit, or alternatively the image recording device may be provided with a storage and a timing device. The timing device permits reading the water meter at predetermined times, for example, at the first of each month, and storing the read data. In this case, the stored data are shown on the display **39** by

activating the structural unit, and then transferred to the transmission camera.

The display is shown in Figure 8b. The display includes not only an image component, but also, within the recording range of the transmission camera, a control display **43**, in which light signals **44** are able to display the status of the counter, and/or a sequence of numerals **45** as the code number for the water meter. Likewise, these data are photographed by the transmission camera **42** and subsequently read into the computer.

In the same way as in the embodiment of Figure 6, the present embodiment also permits illuminating the viewing field under the inspection window **3** of a water meter in a very uniform manner and adapted to the conditions. The description of Figure 6 is herwith incorporated by reference.

NOMENCLATURE

1	Water meter
2	Counting mechanism, display
3	Inspection window
4	Housing
5	Annular seal
6	Guide rail, guide system, guide body, shell
6.1	Guide rail
6.2	Guide rail
6.3	Guide rail
7	Lens
8	Recorder, photosensitive receiver
9	Image reader, camera
10	Focusing lens
11	Data line
12	Identification mark, meter number
13	Mark, starting mark, end mark
14	Starting mark of the identification mark
15	Light source
16	Tunnel
17	Line, water line
18	Manhole
19	Radio set
20	Radio set
21	Energy storage, battery
22	Computer
23	Adapter for connection to central computer
24	Radio controlled remote releasing device
25	Keyboard
26	Light ring
27	Light emitter
28	Shutter

29 End face
30 Reflection ring
31 Holder
32 Guide attachment
33 Impeller wheel, control wheel
34 Lens
35 Photodetector
36 Focusing lens
37 Optical filter
38 Transmitter diode, control lamp
39 Display
40 Structural unit
41 Support
42 Transmission camera, camera
43 Control display
44 Light signals
45 Sequence of numerals
46 Switch
47 Protective cylinder
48 Filter
49 Exit surface
50 Reflection surface
51 Prismatic grooves

C L A I M S

1. Supply meter for measuring and displaying a measured value, wherein for an optically readable display of the measured value a counting mechanism (display 2) is arranged behind an inspection window, and wherein the measured value is alphanumerically shown on the display, characterized in that
an electronic image reader (9) is associated to the supply meter (1), the image reader being adapted to be positioned by means of a guide system above the inspection window, and being provided with an optical system (lens 7), which is adapted to the optical configuration of the inspection window and to the optical situation, in particular the geometric position of the display (2) behind the inspection window.

2. Supply meter of claim 1,
characterized in that
the guide system is arranged on the image reader and includes an adapter, which permits the guide system to be placed on the supply meter for positioning the camera.

3. Supply meter of claim 1 or 2,
characterized in that
the guide system is a frame adapted to the meter in the region of the viewing area and placed thereon, the other end of which mounts or is adapted to receive the image reader (9) that is realized as a camera, and which produces a predetermined spacing between the camera (9) and the viewing area of the supply meter, as well as an alignment of the optical system of the camera with the viewing field.

4. Supply meter of one of the foregoing claims, characterized in that
the image reader connects to a light source for illuminating the display of a consumption value and/or an identification mark, the light source being preferably mounted to the camera or to the guide system.

5. Supply meter of claim 4,
characterized in that
the light source consists of a hollow-cylindrical light ring of a transparent or translucent material, which surrounds the optical system of the camera in a substantially concentric relationship, as well as of one or more light emitters, which are arranged on the front side of the light ring facing the camera for radiating into the light ring, with the light ring preferably serving as at least a part of the guide system.

6. Supply meter of claim 5,
characterized in that
the light ring includes on its end facing the viewing surface of the supply meter an exit surface (49) of the light beams, which is inclined toward the viewing surface or inspection window of the supply meter, preferably inclined in such a manner that the light beams impinge upon the viewing surface or the surface of the inspection window, with the angle of incidence on the viewing surface or surface of the inspection window being selected such that, with inclusion of the refraction on the inspection window, the light enters the inspection window free of reflection.

7. Supply meter of claim 6,
characterized in that

the light ring includes on its side facing the viewing surface of the supply meter a reflection surface (50), which is inclined toward the viewing surface or inspection window of the supply meter in such a manner that the light beams in the light ring are projected on the exit surface (49) of the light ring at a substantially acute angle of incidence.

8. Supply meter of claim 6 or 7, characterized in that
the exit surface (49) of the light ring is provided with annular grooves with a prismatic axial section for refracting the exiting light beams in the direction of the viewing surface or inspection window of the supply meter.

9. Supply meter of one of claims 1-8, characterized in that
between the light ring and the inspection window of the supply meter, a reflector ring is arranged in concentric relationship with the light ring, the reflector ring having a conical reflector surface in facing relationship with the inspection window, which preferably reflects the light beams emerging from the exit surface, and/or the light beams being reflected from the viewing area or inspection window, onto the viewing area or inspection window, with the reflector ring serving preferably at least as a part of the guide system.

10. Supply meter of one of claims 4-9, characterized in that
the light emitters have a substantially monochromatic light or light of a limited wave range, in particular in the green or yellow range.

11. Supply meter of one of the foregoing claims, characterized in that
the supply meter is a water meter (water counter), which includes an inspection window (3), through which the consumption value shown as a line of numerals or reading line can be viewed on the display (2), which is immersed in water.

12. Supply meter of one of the foregoing claims, characterized in that
the image reader is a scanner, which includes an optical system (lens 7) as well as a receiver (8) for a point-by-point recording and storage of the image of the consumption value shown in the reading line.

13. Supply meter of one of claims 1-12, characterized in that
the image reader is a camera, preferably a digital camera, which includes an optical system (lens 7, receiver 8) for recording and storing the image in the viewing field of the meter.

14. Supply meter of one of claims 1-12, characterized in that
the image reader is connected to a comparison device as well as to a computer and software, which permit detecting at predetermined time intervals the time change of the image points of at least a partial area of the inspection window, in which a control wheel with markings or another moved surface with markings is arranged, whose moving speed depends on the function of the supply meter and preferably on the amount of consumption.

15. Supply meter of one of claims 1-13, characterized in that
the image reader includes a photosensitive photodetector, which is directed toward a control wheel with markings located in the inspection window, or another movable surface with markings, and a microprocessor connected thereto, which determines the frequency of the light pulses generated by the markings, and that the moving speed of the control wheel or surface depends on the function of the supply meter and preferably on the amount of consumption.

16. Supply meter of claim 13 or 14, characterized in that
the partial area is illuminated by its own light source (additional light source), whose wave length and/or polarization preferably correspond to those of the other light sources, with the photodetector being preferably preceded by an optical filter in the wave length range and/or polarization range of the additional light source associated to the photodetector.

17. Supply meter of one of the foregoing claims, characterized in that
the supply meter (1), the image reader (9), and the guide system form above the inspection window, a hermetically sealed, watertight, and dustproof unit.

18. Supply meter of one of the foregoing claims, characterized in that
the image reader is wireless, in particular equipped and/or connected, and/or connectible, via radio, ultrasound, an infrared transmitter/infrared receiver, or via a cable to a computer with a program storage and a

program for an alphanumerical evaluation of the read-in images.

19. Supply meter of one of the foregoing claims, characterized in that
the image reader (9) is provided with a data storage for storing the read-in images and data, as well as with a time-dependent switch and/or an electronic remote control, which permit activating the image reader (9) and preferably likewise the illumination of the viewing area of the meter for reading the actual data of the supply meter.

20. Supply meter of one of the foregoing claims, characterized in that
the image reader is adapted for being connected, or is permanently connected via a cable to a display (39), and that the display comprises a support (41), to which a camera (transmission camera 42) is to be mounted in a predetermined position above the display for recording the data shown on the display.

21. Supply meter of claim 20,
characterized in that
the support (41) connects to a protective cylinder, which surrounds the transmission camera (42) in its predetermined position and the display for recording the data shown on the display, and which shields in particular against extraneous light.

22. Method for reading a stationary supply meter with a viewing field, in which a consumed value is optically visible, preferably for reading a water meter, characterized by the steps of

- photographically recording the viewing field;
- converting the optical image into electronic signals;
- transferring the signals to an electronic computer with storage;
- comparing the electronic signals for correspondence with stored signals of all appearing numerals and other alphanumerical characters; and
- outputting the corresponding alphanumerical characters as a consumption value and/or identification data of the reading location (customer data) in the form of an electronic signal train and/or in an optically readable form.

23. Method of claim 22,
characterized by the steps of
- reading the signal train representing the consumption value into an electronic storage;
- reading again the consumption value on the supply meter after expiration of a reading time interval;
- comparing the previous and the actual consumption value; and
- outputting a consumption voucher in the amount of the consumption.

24. Method of claim 22 or 23,
characterized in that
the storage of the data occurs in a computer, which is associated in spatially close relationship to the image reader of the supply meter, and which includes preferably plug connections or other connection elements for connecting to a central computer and/or to communication networks, in particular for carrying out a money transfer by means of remote debiting.

ABSTRACT

An electronic image reader (9) is associated to a supply meter (1), for example a water meter, for measuring and displaying a measured value in an optically readable manner. This image reader is adapted for being positioned or guided in guide systems above an inspection window (3) of the supply meter. The image reader (9) is provided with an optical system -- lens (7) -- which is adapted to the optical configuration of the inspection window and to the optical situation, in particular the geometric position of a display (2) behind the inspection window. The supply meter includes an identification mark (12), which is also located in the region of a guide system, namely guide rails (6.2, 6.3), and which is arranged relative to the guide system such that it can be read with the image reader without changing its optical system.

Fig.1

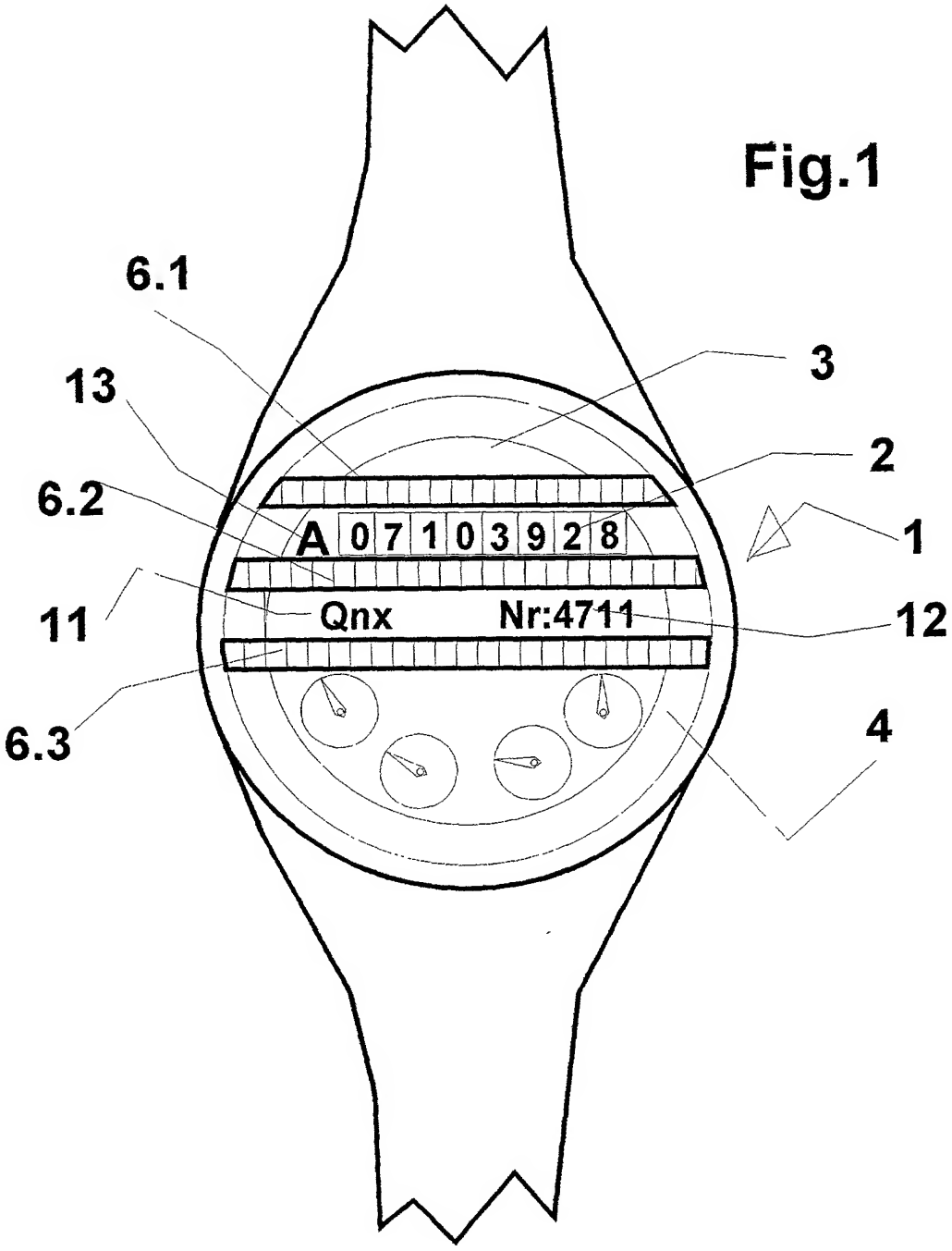


Fig.2

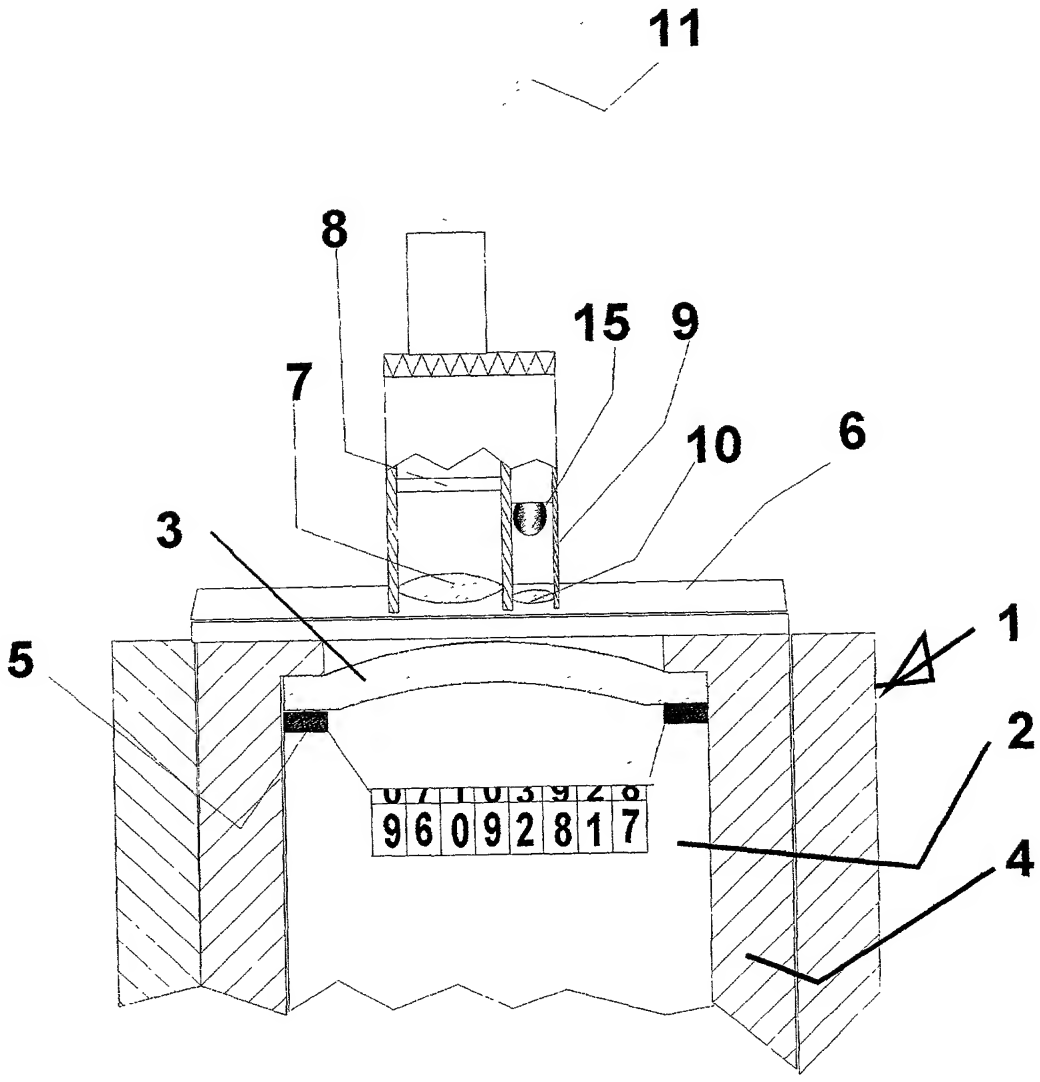


Fig.3

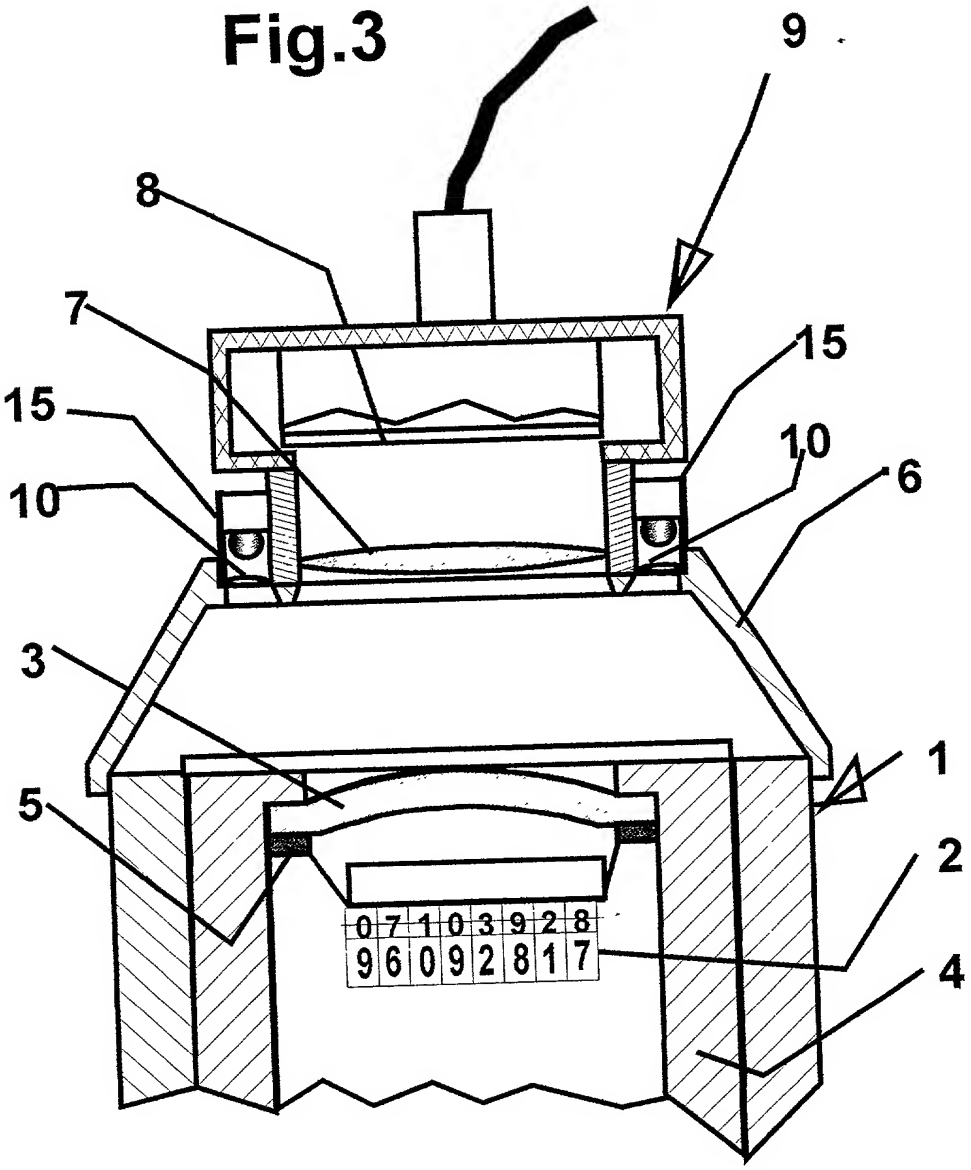


Fig.4

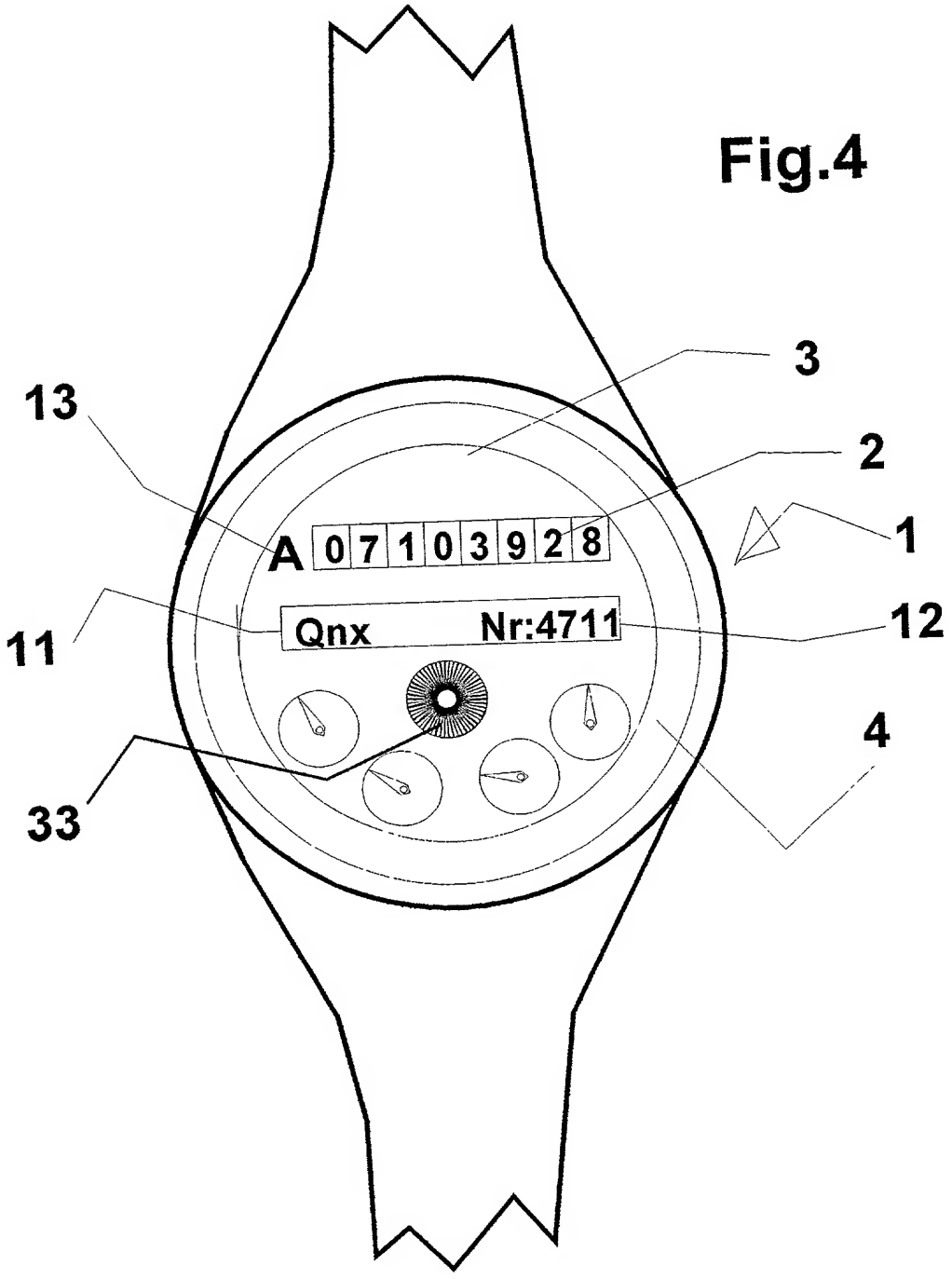
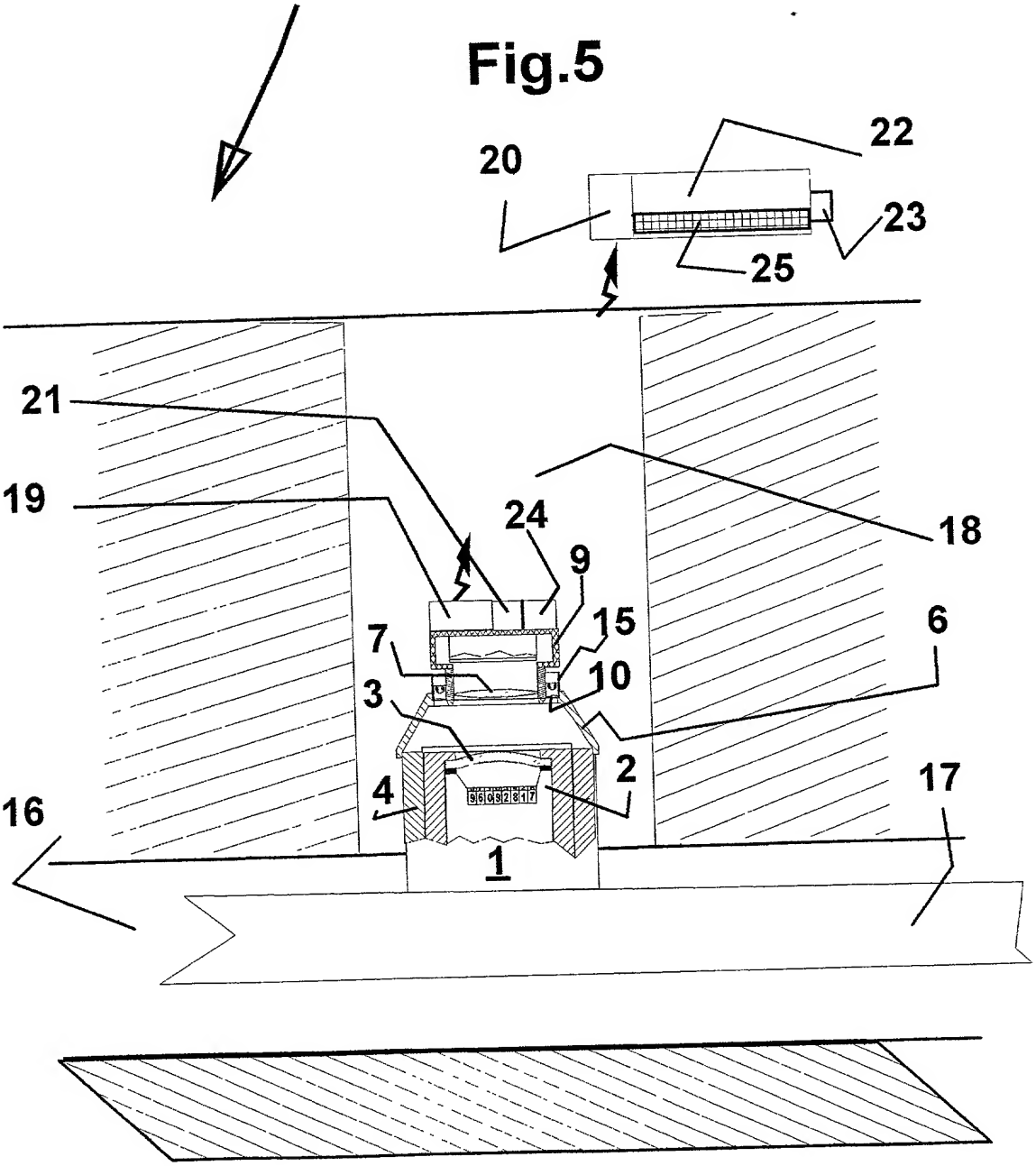


Fig.5



10/019908

Fig.6

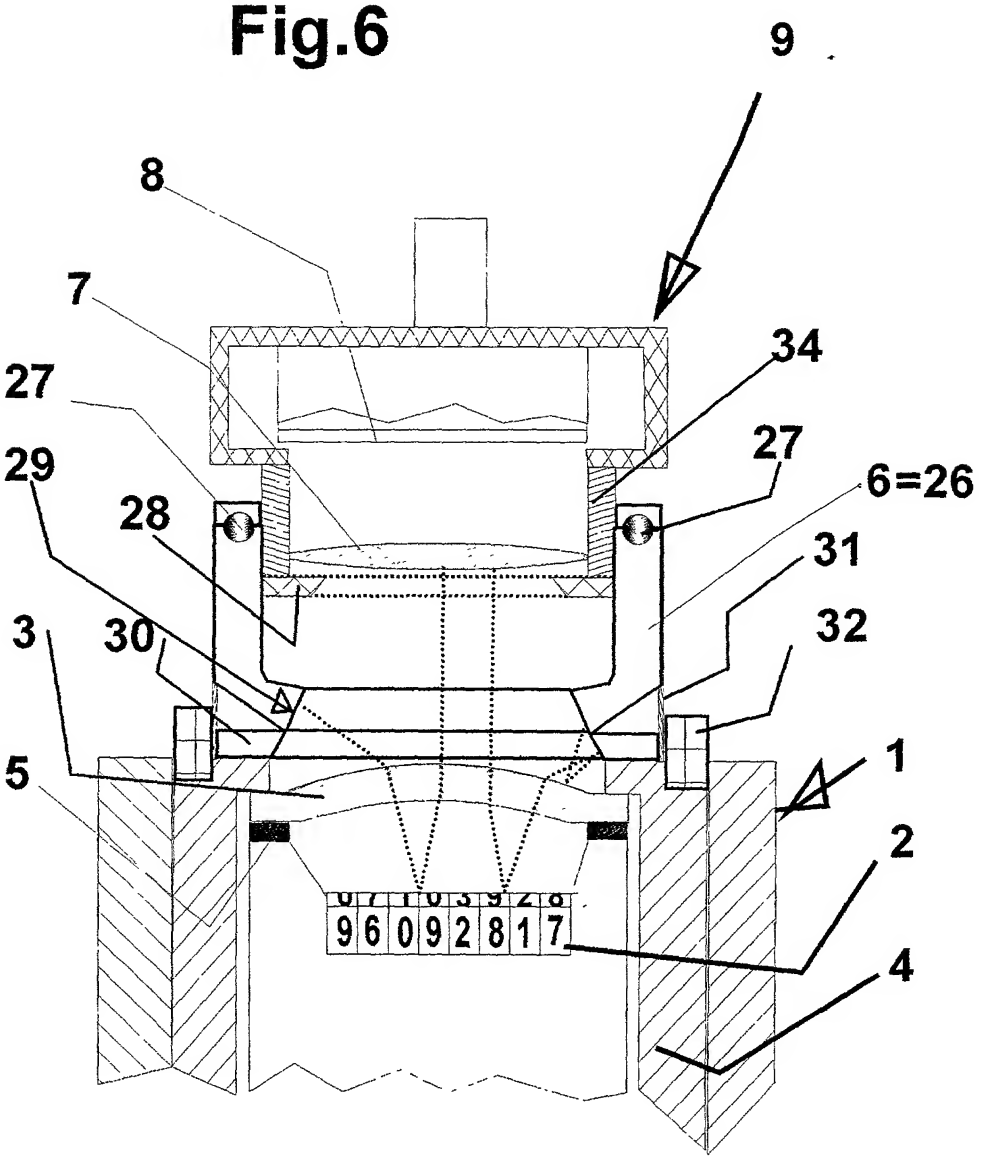


Fig.7

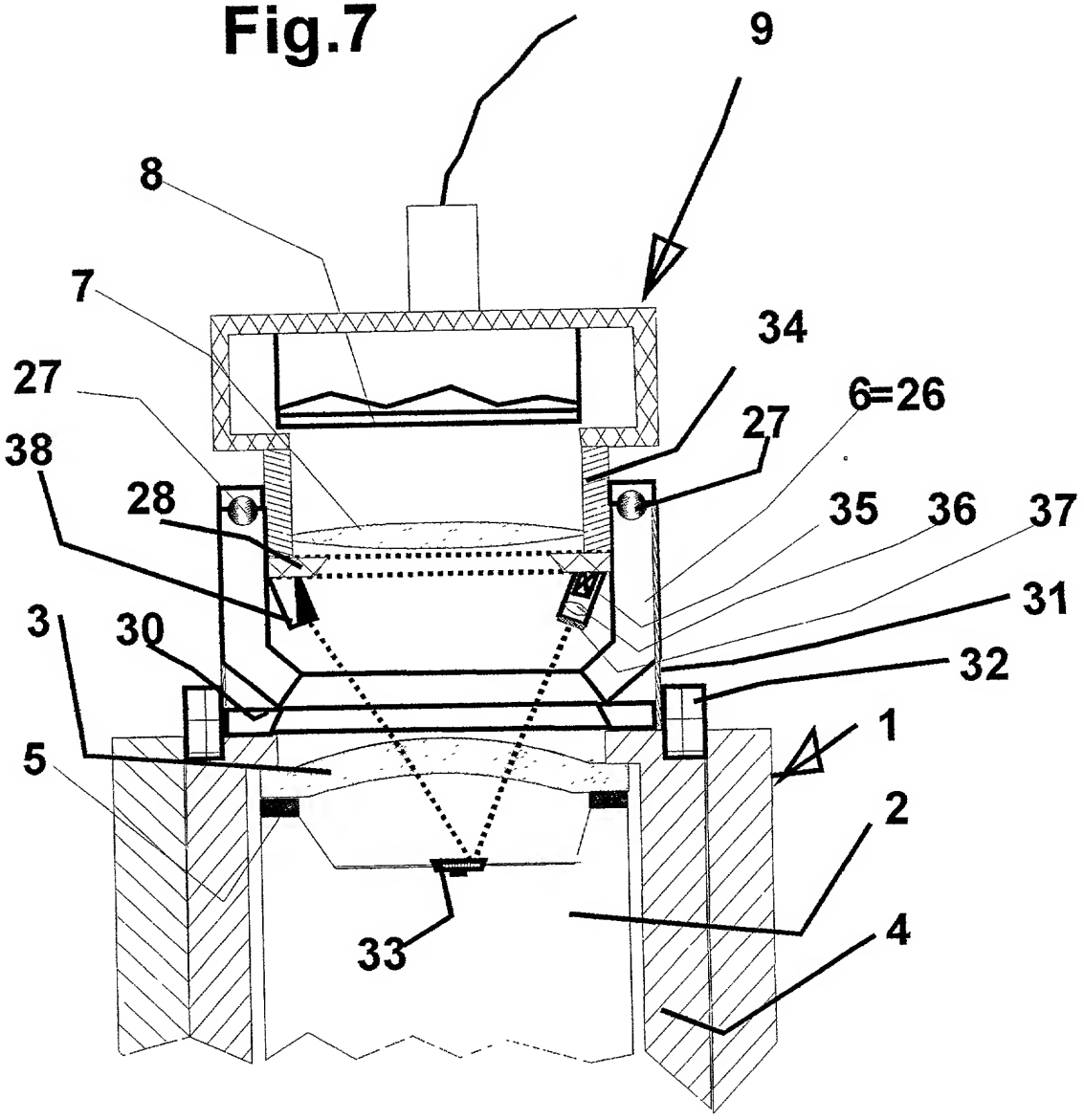
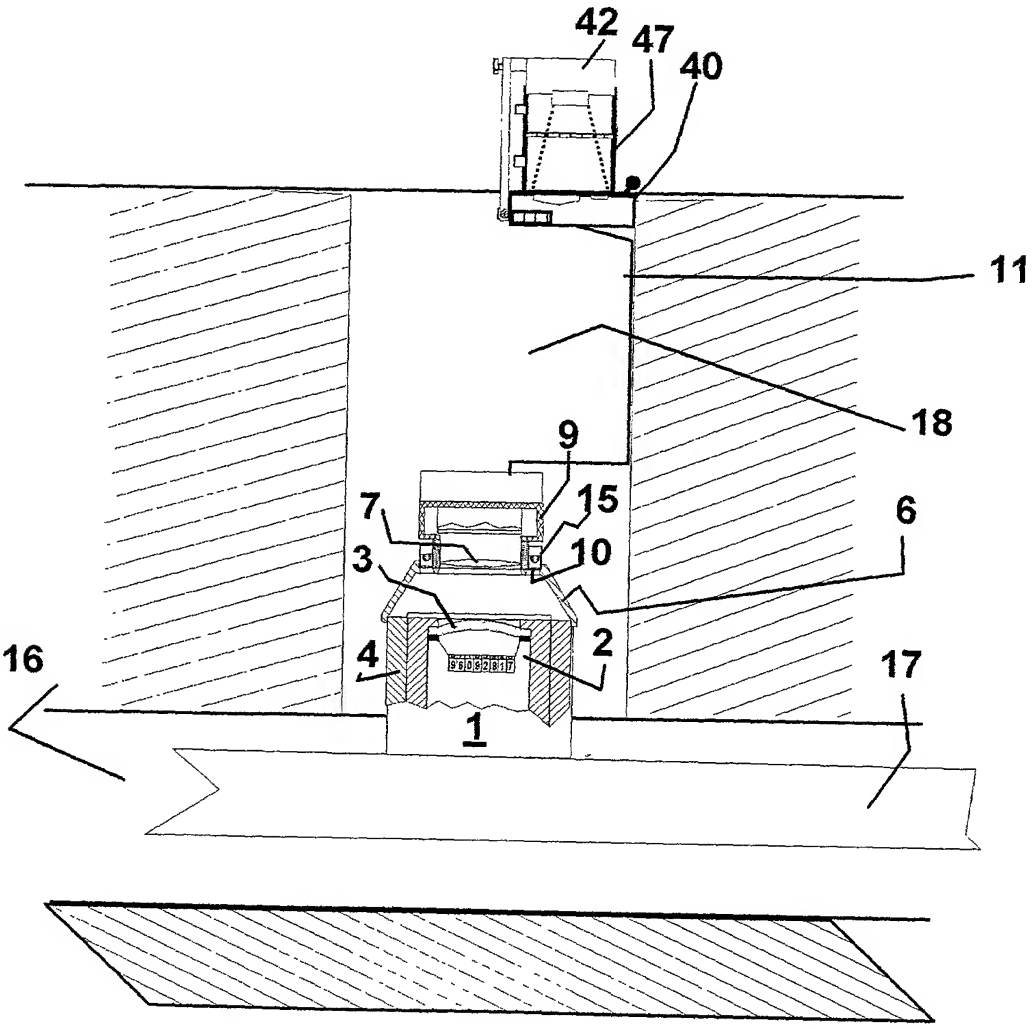


Fig.8



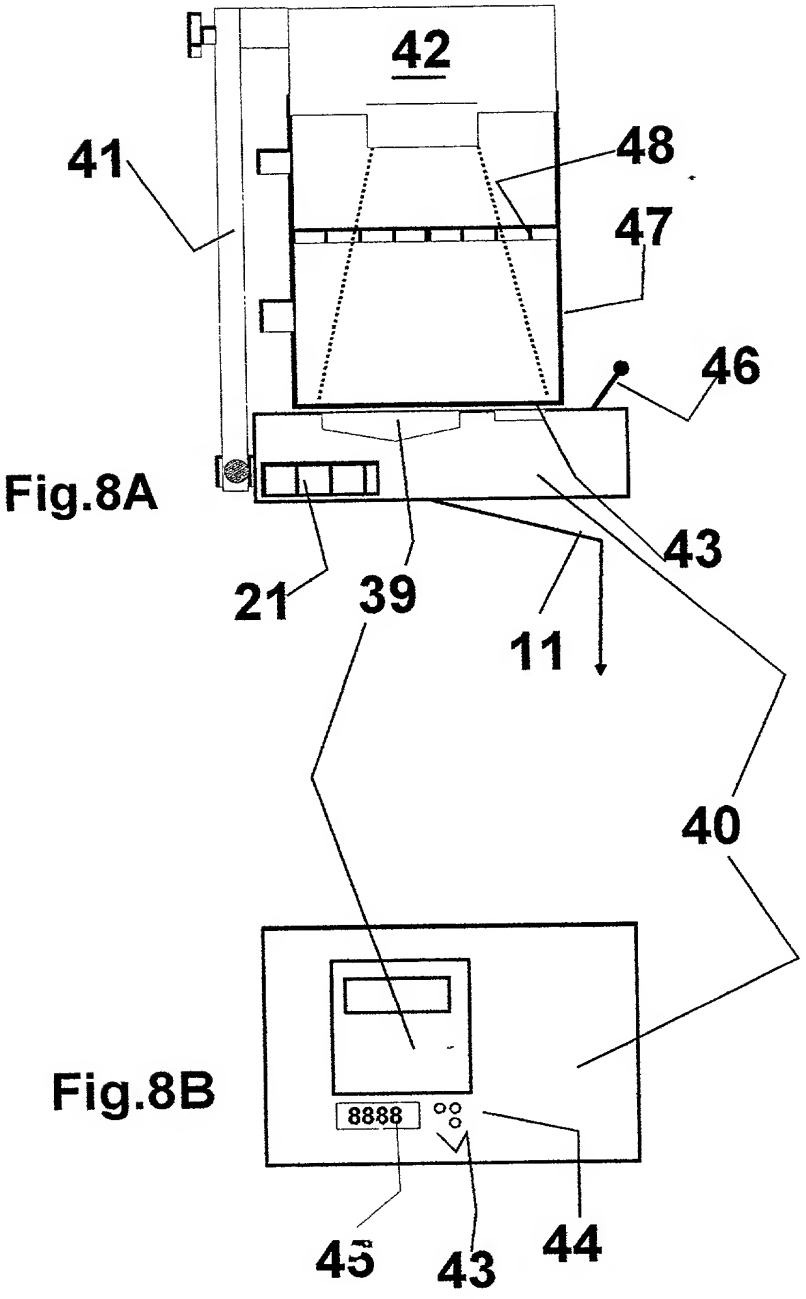


Fig.8A

Fig.8B

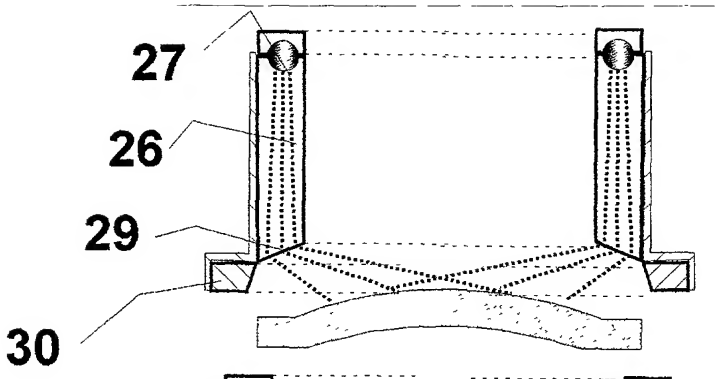


Fig. 9A

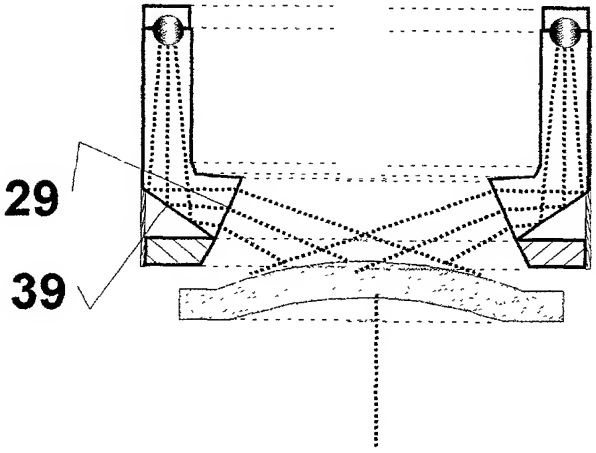


Fig. 9B

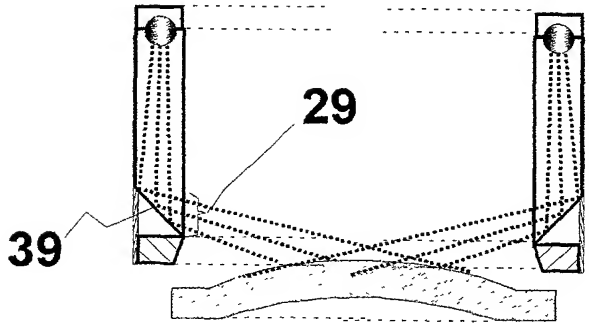


Fig. 9C

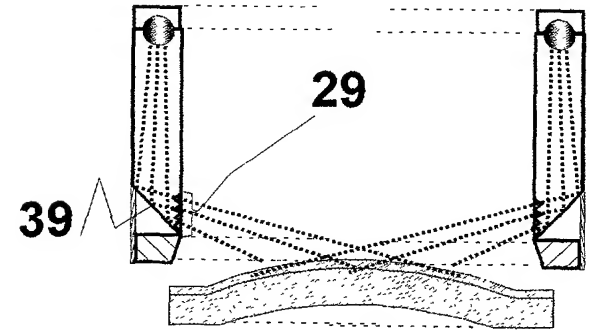


Fig. 9D

Declaration and Power of Attorney for Patent Application

Erklärung für Patentanmeldungen mit Vollmacht

German Language Declaration

Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

daß mein Wohnsitz, meine Postanschrift und meine Staatsangehörigkeit den im nachstehenden nach meinem Namen aufgeführten Angaben entsprechen, daß ich nach bestem Wissen der ursprüngliche, erste und alleinige Erfinder (falls nachstehend nur ein Name angegeben ist) oder ein ursprünglicher, erster und Miterfinder (falls nachstehend mehrere Namen aufgeführt sind) des Gegenstandes bin, der hiermit beansprucht wird und für den ein Patent für die Erfindung mit folgender Bezeichnung begehrt wird:

_____

_____

deren Beschreibung hier beigefügt ist, es sei denn (in diesem Falle Zutreffendes bitte ankreuzen), diese Erfindung

☐ wurde angemeldet am _____ unter der US-Anmeldenummer oder unter der Internationalen Anmeldenummer im Rahmen des Vertrags über die Zusammenarbeit auf dem Gebiet des Patentwesens (PCT)
_____ und am
_____ abgeändert (falls zutreffend).

Ich bestätige hiermit, daß ich den Inhalt der oben angegebenen Beschreibung, einschließlich der Ansprüche, die eventuell durch eine oben erwähnte Änderung abgeändert wurde, durchgesehen und verstanden habe.

Ich erkenne meine Pflicht zur Offenbarung jeglicher Informationen an, die zur Prüfung der Patentfähigkeit in Einklang mit Titel 37, Code of Federal Regulations, § 1.56 von Belang sind.

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

SUPPLY METER AND METHOD FOR READING A FIXED SUPPLY METER

the specification of which is attached hereto unless the following box is checked:

☒ was filed on **May 6, 2000**
as United States Application Number or PCT International Application Number
PCT/EP00/04043 and was amended on
___(if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56.

German Language Declaration

Ich beanspruche hiermit ausländische Prioritätsvorteile gemäß Title 35, US-Code, § 119(a)-(d), bzw. § 365(b) aller unten aufgeführten Auslandsanmeldungen für Patente oder Erfinderukunden, oder § 365(a) aller PCT internationalen Anmeldungen, welche wenigstens ein Land außer den Vereinigten Staaten von Amerika benennen, und habe nachstehend durch Ankreuzen sämtliche Auslandsanmeldungen für Patente bzw. Erfinderurkunden oder PCT internationale Anmeldungen angegeben, deren Anmeldetag dem der Anmeldung, für welche Priorität beansprucht wird, vorangeht.

I hereby claim foreign priority under Title 35, United States Code, § 119(a)-(d) or § 365(b) of any foreign application(s) for patent or inventor's certificate, or § 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Applications (Frühere ausländische Anmeldungen)			Priority Not Claimed Priorität nicht beansprucht
199 21 357.7 Number (Nummer)	**DE** (Country) (Land)	**10 May 1999** (Day/Month/Year Filed) (Tag/Monat/Jahr der Anmeldung)	☐
199 42 582.5 Number (Nummer)	**DE** (Country) (Land)	**07 September 1999** (Day/Month/Year Filed) (Tag/Monat/Jahr der Anmeldung)	☐
199 52 083.6 Number (Nummer)	**DE** (Country) (Land)	**30 October 1999** (Day/Month/Year Filed) (Tag/Monat/Jahr der Anmeldung)	☐
200 04 969.0 Number (Nummer)	**DE** (Country) (Land)	**17 March 2000** (Day/Month/Year Filed) (Tag/Monat/Jahr der Anmeldung)	☐

Ich beanspruche hiermit die mir unter Title 35, US-Code, § 120 zustehenden Vorteile aller unten aufgeführten US-Patentanmeldungen bzw. § 365(c) aller PCT internationalen Anmeldungen, welche die Vereinigten Staaten von Amerika benennen, und erkenne, insofern der Gegenstand eines jeden früheren Anspruchs dieser Patentanmeldung nicht in einer US-Patentanmeldung, bzw. PCT internationalen Anmeldung in einer gemäß dem ersten Absatz von Title 35, US-Code, § 112 vorgeschriebenen Art and Weise offenbart wurde, meine Pflicht zur Offenbarung jeglicher Informationen an, die zur Prüfung der Patentfähigkeit in Einklang mit Title 37, Code of Federal Regulations, § 1.56 von Belang sind und die im Zeitraum zwischen dem Anmeldetag der frühren Patentanmeldung und dem nationalen oder im Rahmen des Vertrags über die Zusammenarbeit auf dem Gebiet des Patentwesen (PCT) gültigen internationalen Anmeldetags bekannt geworden sind.

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s), or § 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application.

(Application No.) (Aktenzeichen)	(Filing Date) (Anmeldetag)	(Status) (patented, pending, abandoned) (Status) (patentiert, schwebend, aufgegeben)
(Application No.) (Aktenzeichen)	(Filing Date) (Anmeldetag)	(Status) (patented, pending, abandoned) (Status) (patentiert, schwebend, aufgegeben)

Ich erkläre hiermit, daß alle in der vorliegenden Erklärung von mir gemachten Angaben nach bestem Wissen und Gewissen der Wahrheit entsprechen, und ferner daß ich diese eidesstattliche Erklärung in Kenntnis dessen ablege, daß wissentlich und vorsätzlich falsche Angaben oder dergleichen gemäß § 1001, Title 18 des US-Code strafbar sind und mit Geldstrafe und/oder Gefängnis bestraft werden können und daß derartige wissentlich und vorsätzlich falsche Angaben die Rechtswirksamkeit der vorliegenden Patentanmeldung oder eines aufgrund deren erteilten Patentes gefährden können.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements we made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

German Language Declaration

VERTRETUNGSVOLLMACHT: Als benannter Erfinder beauftrage ich hiermit den (die) nachstehend aufgeführten Patentanwalt (Patentanwälte) und/oder Vertreter mit der Verfolgung der vorliegenden Patentanmeldung sowie mit der Abwicklung aller damit verbundenen Angelegenheiten vor dem US-Patent- und Markenamt: (Name(n) und Registrationsnummer(n) auflisten)

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) to prosecute this application and transact all business in the Patent and Trademark office connected therewith: (list name and registration number)

James A. Witherspoon
Reg. No. 36,723 and All Attorneys registered with
Customer Number 000826

Postanschrift:

Send Correspondence to:
Customer No. 000826

Telefonische Auskünfte: (Name and Telefonummer)

Direct Telephone Calls to: (name and telephone number)
James A. Witherspoon
(704) 444-1000

Vor-und Zuname des einzigen oder ersten Erfinders	**Full name of sole or first inventor** **Michael Schröter**
Unterschrift des Erfinders Datum	Inventor's signature Date Oct. 30, 01
Wohnsitz	Residence **Remscheid, Germany**
Staatsangehörigkeit	Citizenship **Germany**
Postanschrift	Post Office Address **Timmersfeld 1**
	D-42899 Remscheid, Germany

#4503580v1